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Copying and Making Patterns from an Old Propeller Wheel.

BY J. WHITEHEAD.

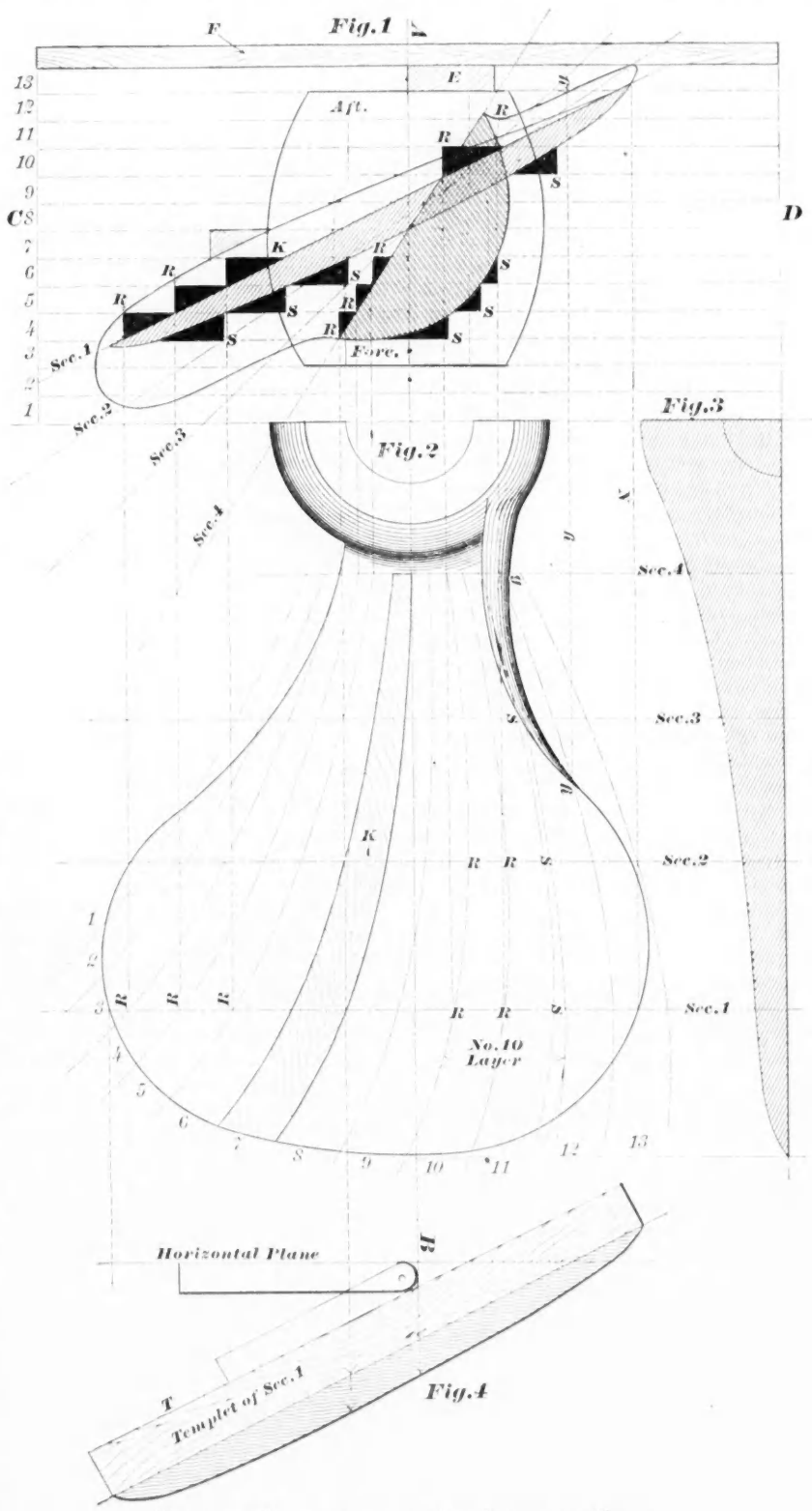
There are propeller wheels made of almost every conceivable curvature of surface. It often happens that when a wheel in actual operation gives good satisfaction under certain conditions, that it is desired to make one of the same curvature, with, perhaps, a slight alteration of the pitch or diameter to suit any varied conditions. To accomplish this, I have seen a blade cut off the old casting and used for a pattern, but this is not practicable in most cases, and is very expensive in machine work and moulding. Another method is to make a frame template and fit it upon the face, and then to build the pattern upon it. Another plan is to erect a spindle in the center of the bore, fastening a board to the spindle at right angles to it. At certain distances upon the board slide gauge sticks from the surface of the board to the face of blade, and note the rise in relation to the revolution of the spindle. From this curved sections are obtained at the various points. The following method is one I arranged, and have used for several years, and it will be found cheaper and more accurate, as well as being easier.

TO COPY THE WHEEL.

Take the wheel or casting to be copied, and set it so that the bore will stand perfectly vertical, or that the top edge of the blades be on a level plane. Place a cross-bar in the bore, and find the center. Lay the straight edge, *E*, Fig. 1, on the face of the hub at the center, and strike the center of the blade as it joins the hub at *C*, *D*, Fig. 1. Describe the radial line, *A*, *B*, on the face of the blade by dropping a plumb line from the edge of the straight edge, *E*. Lay off the points of proposed sections 1, 2, 3 and 4, Fig. 2, on straight edge, *E*. Take another straight edge, *F*, and set it at right angles to *E*, at the point of section 1, and describe the line sections at each point with a plumb line upon the face of the blade, as shown in Fig. 2. Taking away the straight edges, now make the template, *K*, Figs. 1 and 2. For this you will require the wood planed to the same thickness as you intend to build up your wheel, say 1″ in this case. Then fit it to the face of the blade, the top face of the board being kept on a level plane, at *C D*, Fig. 1, by using a spirit level. This will give you a beveled edge of various angles, and by cutting off the angular parts square with the top face it will appear as shown by *K*, in Fig. 2. Mark off the sectional lines 1, 2, 3 and 4 on face of the template, and the intersection of face of template upon the face of blade, which is the horizontal plane, *C D*. Now, make templates to fit the blade at each one of the sections 1, 2, 3 and 4, being careful to mark upon them when fitted the intersection of the center line, *A B*, horizontal plane, *C D*, and the outer edges of the blade, as shown in Fig. 4. Straighten top edge of template at *T*, and find the angle with a spirit level at which it sets to the horizontal plane. Caliper the thick part of each section and lay off, Fig. 3. (I have shown the face of sections straight for convenience, but any curve can be treated the same way.)

TO LAY DOWN THE WORKING DRAWING.

With these templates you may proceed at any future time to lay off the wheel, full size.



MAKING A PATTERN FROM AN OLD PROPELLER WHEEL.

For the elevators, Fig. 1, lay off on a board parallel lines spaced the thickness of your layers, in this case 1″ apart. Lay down your center lines, *A B* and *C D*, *C D* being one of the parallel lines. Take section template No. 1 and lay it on the board with the vertical center on line *A B*, and the horizontal center on line *C D*, while the back of template is set to the angle from the horizontal plane, as noted. Mark a line from the template edge, and check off the points of outline of blade on that section. In like manner lay off the other three faces of section. Next lay off thickness of sections from Fig. 3, with easy curves to the outline of blade. Erect perpendiculars at all points of intersection of each layer with the face of section, as shown at *R*, *R*, *R*. Now lay out the plan as in Fig. 2, first taking a center line, *A B*, and laying off sectional lines 1, 2, 3 and 4, also the center, and circumference or periphery from the straight edge, *E*. The points of intersection of each layer can be transferred from elevation to the plan, as shown by dotted lines *R*, *R*, *R*, and on each section on plan. Use template *K* to lay off the curve between these points, which will be perfect in the center at No. 7, and any deviation at the outer part can easily be detected from the points of intersection, and can be allowed for accordingly. The outline of the blade can be made by curves cutting through the outline points on the sections, taken from Fig. 1 to Fig. 2, as shown at *N*, being sure to leave the curves full. This outline can be traced upon the elevation, Fig. 1, by transferring points of intersection of radial line with outline on plan, as shown by dotted line, *Y*.

TO MAKE THE PATTERN.

To make the pattern, first saw off boards 2″ or 3″ longer than the length from section 4 to the circumference. Plane down to 1″ thick, truing both sides. For example: Lay off the front-edge curve of No. 10 layer from Fig. 2 upon one edge of a board, and saw it true to the line. Place the curved edge in its place on the plans, transfer the sectional lines 1, 2, 3 and 4 upon it, and also the circumference. Lay off *R R* and *S* from Fig. 1 on each section to the sectional lines upon layer. Connect *S* of each section by an easy curve that will intersect them. Mark the piece No. 10, and saw out the back and ends carefully. Each layer is got out by the same course. To glue them up, take the first full course, No. 2, and screw it on the table from underneath; and for the rest, bore three holes for screws on the top face of each layer between *R R*. In laying up, be careful to set the curved edge on the points at *R* of the lower layer, and see that the sectional lines are in line. When the glue is dry, take out the screws and dress the face to the lines of intersection of layers, mark the outline of face and dress it, then dress the back the same way as the front. The hub is made separate, and can be bolted to the blades so that it can be changed in the pitch by revolving on the center at intersection *A*, *B*, *C*, *D*. Slight changes in the diameter can also be made in this joint.

Drawing for Mechanics.

BY COLEMAN SELLERS, JR.

The following lecture was delivered in the hall of the Franklin Institute, Philadelphia, on the evening of February 8, to a crowded and appreciative audience:

On a former occasion I addressed you on the subject of mechanical drawing, or "constructive drawing," as it has been properly called, because it is used to indicate how objects are to be made, and differs entirely in its scope and treatment from representative drawing, which endeavors to portray objects as they appear, and decorative drawing which treats of ornamentation.

My object, on the occasion to which I refer, was chiefly to point out to you the importance of availing yourselves of every opportunity to study and to practice constructive drawing, because a knowledge of its principles will be found of great value to every one, and is simply indispensable to every handicraftsman who desires to be proficient in his occupation. I further urged that drawing should be taught in our schools, not as a merely ornamental addendum to an education, but as a prime necessity, as of co-ordinate importance with the three "R's"—Reading, 'Riting, and 'Rithmetic. Indeed, I see no reason why instruction in drawing should not precede instruction in writing. Many children begin to understand simple pictures before they learn to talk.

I also showed you that mechanical drawing differs from representative drawing in that it is based upon certain conventional ideas. It is not, like the picture, readily understood by every one who has eyes, but requires some

knowledge of the principles upon which it is based; and from this I argued that there arises a necessity that the instruction of our schools and colleges should follow closely the best practice of the drawing office and workshop: that the principles and conventions taught in one should be those practiced in the other, so that our school instruction should be of immediate value to us in the workshop. Constructive or mechanical drawing we usually regard as requiring the use of drawing instruments, and as being quite independent of manual dexterity unassisted by straight edge and compass—a sort of facility which is supposed to be necessary only to that superior creature, the artist or representative draughtsman.

Now, my object this evening is to show you, if I can, how valuable to the mechanical draughtsman a little knowledge of free-hand drawing may be; to describe the important part which the free-hand sketch plays in the working of mechanical drawings, and to show you that with certain limitations such sketches may become perfectly reliable constructive drawings themselves.

I also desire to speak of certain principles and practices which should obtain in the drawing office.

Free-hand drawing is of value to the mechanical draughtsman as an educator of eye and hand, and as a means of recording ideas and facts. Since I last addressed you, I have heard some strong testimony on this subject, and I can recall none stronger than that of Mr. James Nasmyth, whose autobiography you have, most of you, no doubt read (and if any of you have not read it, I should advise you to do so at once). Mr. Nasmyth, who, from small beginnings and without money or influence, built up a large and flourishing business and established a wide celebrity as an engineer, attributes his success—largely, as you may remember—to his facility in off-hand sketching. "Drawing is," he says, "the education of the eye. It is more interesting than words. It is graphic language."

He also calls mechanical drawing the "alphabet of the engineer;" says that without it the workman is merely a "hand," but with it he indicates the possession of a "head." He enlarges at length upon the pleasure and profit he has derived from his skill in ready free-hand sketching, and tells of his note books filled with scraps of sketches by the way, which recall to his mind pleasant journeys and many happy recollections. The force of written words may be lost, but the pencil recollections imprint themselves on the mind with a force that can never be effaced; and such sketches may have a practical value to the mechanic as a means of recording and preserving mechanical details and devices which may afterwards be successfully applied. Like other sketchers who have traveled in strange lands, Mr. Nasmyth tells the usual story about ordering his dinner by the "graphical method," as it were. His version is that he stopped at a roadside inn, in the Swedish province of Dannemora. He could not talk Swedish, and the landlady knew no English; he, therefore, resorted to his pencil, and made a sketch of a dinner table, and described the results as being eminently satisfactory.

Mr. Nasmyth's experience was not an unusual one; knowledge can often be conveyed from one person to another far more surely and correctly by even a crude sketch than it can be by any combination of words.

In a recent number of one of our technical papers, I noticed this definition of the mechanical movement which is called the "Whitworth quick return." The writer says: "As is generally known, it consists of a crank upon one shaft, surrounding the pin of which is a block or roller sliding in a radial slot (in effect another crank of varying radius), in a disk or plate upon the other, the two shafts being placed end to end, but not in coincident axial lines." Now, this is probably a nearly correct general description, but it seems to me that a majority of those persons who read that paper would fail to gather from those words any adequate idea of the appearance or operation of this well-known device; while a simple sketch would enable any one to understand it. But first let us inquire what is meant by a quick-return movement, and what it is used for. A certain class of metal planing machines, called shapers and slotters, reproduce to a certain extent the movement of the carpenter's jack plane; that is, the planing tool is passed over the work, which is stationary, by successive strokes, the planing tool returning after each stroke to the starting point. Now, in order to save time, it is important to make the return stroke as quickly as possible, and a device is required which will cause the tool to advance at a regular rate of speed and then return at an accelerated velocity. This effect is accomplished in various ways, and very simply and effectively by the Whitworth quick-return motion, so called from its inventor, Sir Joseph Whitworth.

The graphical method of instruction, where it can be applied, is by far the most effective way of teaching, and it is particularly successful with certain scholars. I recollect well how I labored, when a schoolboy, over the rules of syntax. I memorized the rules as best I could, and tried to worry through the exercises in parsing, but had not the slightest idea of what it was all about. Then I changed schools, and at the new school they used a text-book that had all the various parts of speech arranged in simple diagrams, which showed at a glance the true relation of the various parts of a sentence, and at once I found that the driest of all my tasks became one of the most interesting, simply because its principles were put before me in such a manner that I could readily grasp the meaning. Our ability to sketch an object is a pretty sure test of our knowledge of it. Endeavor to make a sketch of something from memory, and you will find out at once if you really know anything about the subject. Try to recall even the ground plan of the house you live in—simply the arrangement of the rooms and their relative sizes. I'll venture to say very few of you can make so simple a sketch of such a familiar object and get the proportions and positions even approximately correct. Drawing cultivates habits of definite observation, and definite observation is indispensable to the mechanic. You cannot reproduce a machine—you cannot copy a simple mechanical contrivance—if you have a mere general idea of its appearance or action. You are obliged to note its operation at each point, and to trace out the relation of each part to all the others. If you do not do this, you will find gaps in the mechanism that you cannot account for, and where you least expect them.

An army officer once showed some illustrated newspapers to a young Indian, who was very much interested in some of the pictures. He examined them carefully, and then taking out his knife he followed with its point the outline of its different figures, and explained that he did this because it would then be easier to carve them when he went home; in other words, he was compelling himself to take *definite* observations. By laboriously following each line with the point of his knife, he fixed in his head each detail of the drawing. The faculty of definite observation, coupled with an ability to remember form, is possessed in an extraordinary degree by certain uncivilized races. The Esquimaux, for example, are able to remember the natural features and the geographical peculiarities of a vast extent of country, and can draw maps which are singularly accurate. Captain Hall once met an Esquimaux who drew from memory a chart of a region extending between two points over 1,100 miles apart, and having a coast line so indented by arms of the sea that its length is over 6,000 miles; and upon comparing this with a map carefully made by a surveying party, the resemblance was found to be wonderfully close.

So important to the artist and draughtsman is the remembrance of form, that special means have been taken by certain eminent teachers of drawing to develop it by forming a habit of definite observation. For example, the object to be drawn: At first a simple model is placed before the class for, say, two or three minutes; then, after it has been removed, the scholars are required to draw it from memory. This operation is repeated, and the complexity of the models gradually increases as the memory develops, while as an aid to the memory the students are required, while the model is before them, to trace its form with a pencil, in the air, precisely as though they drew its outline upon a sheet of transparent glass interposed between them and the model; thus repeating the method of the Indian who followed the drawings with his knife point.

Sometimes the accuracy with which the form of an object is retained in the mind is such, that its image seems to exist as a complete mental picture which may be summoned before the mind's eye at will, and examined or copied precisely as though it were an actual drawing. Mr. Francis Galton, who has devoted much thought and attention to this subject, says that the Bushmen of South Africa drew most correct and lifelike representations of men and animals, and from their method of drawing he thought they simply copied the visual images which they were able to conjure up before the mental vision. The process which he describes as that which they followed was this: The artist would begin his sketch by putting down, apparently at random, a number of dots spaced like the stars in the firmament, and when he had revised them to his satisfaction he joined them by rapid free lines and the likeness at once appeared, the effect produced being excellent, though crude.

Perhaps the mechanical draughtsman seldom, if ever, uses this visual image which each of us can call up in some degree, greater or less; but he none the less requires carefully to cultivate his powers of accurate observation, and this he can most readily do by practice in free-hand sketching. But aside from its value as an educator, the free-hand sketch plays a most important part in constructive drawing.

Perhaps the first use of the free-hand sketch to the draughtsman is in originating or inventing.

You must recollect that in any large drawing office the greater part of the designing must be schemed out by persons who understand what is to be done in each case, but do not themselves make the actual working drawing. Now, before this can be made, the draughtsman must understand fully what he is required to draw, and it is here that the rough sketch first appears.

I know of no case which will illustrate this process better than one which is given in Nasmyth's Autobiography, where he describes his invention of the steam hammer. The story is this: It was required in 1839 to procure a paddle-wheel shaft, 30″ diameter, for the steamer Great Britain, which was then being constructed, and, much to the mortification of the builders, it was found that no forge was prepared to undertake so large a piece of work. The hammers then in use were helve hammers, driven by water or steam power. And Mr. Nasmyth conceived the idea of applying steam to lifting a large mass of iron directly, thus permitting it to fall vertically upon the work.

It is a very excellent plan for the draughtsman or mechanic to do all of his rough sketching in a book, which can be preserved. There is a great temptation to do such work on odd scraps of paper. You generally feel that such work is only temporary, and that you probably will never require to look at the figures again, but a little experience will show you that it is a positive convenience to be able to refer back to old calculations and sketches, and by preserving them you will save yourself much unnecessary recalculation.

It is a common practice now in drawing offices to furnish their draughtsman with rough sketch-books for this purpose, and they are urged to use them upon all occasions, no matter how trivial; and I for one can bear witness to the convenience, economy and neatness of this arrangement. The free-hand sketch may be used to great advantage for many of the simpler constructive drawings, such as details or parts of machines copied from the carefully-made drawings, which give the sizes and proportions of the various parts. They need not be to scale if the dimensions are properly marked.

Of course, any machine which is to be frequently repeated may, and, in fact, should, be represented by careful drawings of every part, but there arise many cases where the free-hand sketch will answer every purpose, with a saving in time and money, and for such purposes it can be used with safety and satisfaction if our caution is observed. It must be a fixed principle of every drawing office that no original drawing should be allowed to go into the shop; that is, you must have an absolute record of everything which goes out of the drawing office. This is necessary to guard against the possibility of loss or accidental destruction or injury. You must be able to replace easily and cheaply any copy thus mislaid or injured, and to do so you must keep an exact record of all that you send out. This was formerly done by making tracings on cloth or paper, and these tracings were sent out while the original drawing was retained in a safe place. As a precaution against loss and injury the paper tracings intended for the shop were mounted on drawing boards and coated with transparent varnish to preserve them. These tracings are not wholly satisfactory because they are expensive to make, and because there is no certainty that they are exact copies in every minute respect of the original; or, in other words, the original drawing may not be a reliable record of the tracing which you have sent out. It is therefore better practice to make blue print copies of the tracing and to send these copies out into the shop.

Any number of copies can be made at a trifling cost and the copy is an exact reproduction of the original tracing. In case of subsequent alteration a new tracing is made and the former tracing filed as a record of a step in the evolution of the machine. Returning to the rough sketch of which I spoke a similar system may be adopted.

It is only necessary to make all such sketches in copying ink and taking press copies of them before they are allowed to leave the office. To do this requires but a few minutes time and gives us a complete record of each sketch that is sent out, and in case additional copies are required the copy book impression may be blue printed. For convenience, blank forms of several sizes are prepared (say page, half page and third page of copy book) on cheap tinted bristol board with proper printed headings and ruled in $\frac{1}{4}''$ squares. This gives uniformity to the sketches and the ruling aids materially in drawing to approximate scale.

I have only a few words to say in conclusion. The value of drawing as a factor in education is gradually being recognized, and many efforts are being made to put instruction in drawing within the reach of every boy and girl. The drawing schools are well attended, and an interest in the art in its various forms seems to be awakened. Let us hope that these efforts may, in the near future, bear fruit, and that the day is not far distant when our manufacturers can procure educated designers and draughtsmen for any branch of industry without the necessity of importing them from Europe.

Work in the Baldwin Locomotive Shops.

We are authorized to state that the reports going the rounds of the press that the Baldwin Works have received an order for 120 locomotives for Russia are without the least foundation. They have not received any orders from Russia for some years, and do not expect any at present. All the foreign orders this firm has are for sixteen locomotives for South America, and one for Cuba. Some engines are in the works for Australia, but they are nearly ready for shipment. Orders are getting very scarce, and the company expect to reduce their force of workmen directly should no improvement in the business prospects intervene. In looking round the works, we noted several new features of construction. They have adopted a new plan of connecting the top and bottom frames at the front end of consolidation engines. The lower frame is curved up in front of the cylinders, carried below and parallel to the top frame, and the two are joined at the extreme

front by means of a heavy casting, to which the bumper beam is attached. It makes the front end very strong, to withstand the shocks of heavy freight service. There is a group of engines in course of construction for the Norfolk and Western Railroad, which is five feet gauge. As it is intended to close the gauge of this road, the engines are made in such a way that they can be readily adapted to standard gauge. The usual way of preparing a locomotive for a change of this kind is to insert a block between the saddle openings to admit of the cylinders being closed. This, of course, entails changing the position of the frames all round, and the wheels have to be moved on the axle. All that work will be saved on these engines. The driving wheels are cast very wide, so that when the tire is placed on the outside they are wide enough for five-foot gauge. When they want the engines for standard gauge, all they have to do is to heat the tires and move them to the inside edge of the wheel periphery, when they will be ready for work. To do that and move the truck wheels on their axles is a small job for such an important change.

On a Standard System of Parts for Machine Tools.

BY JOHN J. GRANT.

The lack of some recognized standard for the various parts of machine tools is, to say the least, very annoying to the users of such tools, and should, I think, lead to the adoption of standards for the parts in which interchangeability would be as much benefit to the makers as to the users.

That this can be brought about with very little trouble or expense to the makers, and with an unlimited amount of good to the owners and users of such tools, hardly admits of a question. Facts are stubborn things, and as this paper is composed of such, being the result of several years' experience in the use of the lathe and its accessories, with a few years spent in designing machine tools in general, I will say that I think the thing most to be desired in machine tool construction is a system of standards for the various parts requiring the interchange of fixtures and tools.

There must be a beginning to every undertaking, and as the Society of Mechanical Engineers has amongst its members men who have, by their long years of experience, obtained a world-wide reputation as tool-builders, I would recommend that a committee from amongst their number be appointed to confer with the makers of machine tools, who, I am sure, would conform to any standard adopted by the society as recommended by the committee. Any member of the society who has used machine tools (and there are a large proportion of them that have done so) will see the great advantage to be derived from the uniform standard on machine tools.

Some of the points on the engine, or other lathes that require uniformity are, first, a certain size for the front end of the line spindle for a given swing of lathe, the thread on this part also being a standard pitch, and with the proper length of thread, and plain or unthreaded part. Next, a uniformity in diameter and taper of centers for a given swing of lathe, and next a uniform ratio of gearing for the same swing of lathe, and the same direction of movement for all hand wheels. Although the last two mentioned are not as essential as the other, yet any one having worked in the shop knows the annoyance, in changing from one lathe to another of a different make, to find the ratios of screw cutting gears entirely different, and the hand wheels moving from right to left, instead of from left to right.

There should also be a uniformity in the size of opening in the tool post, to admit of standard sizes of tool steel, as tools sent to the tool-dresser could then be carried to the stock or tool room and given out to the workman, by his giving the swing of the lathe, he knowing that the tools would be all right. There may be, and probably are, other points about the lathe that require a uniform standard; and should a committee of practical tool builders confer together, many points would certainly be brought out that would benefit the entire machine industry.

The standard taper need not necessarily stop at the lathe alone, but could be used for the drilling machine, milling machine, and, in fact, every machine tool requiring a taper center and having a certain diameter of spindle might have the same diameter and taper of center holes for either drill chucks, center or arbors.

For the planer there seems to be but little need of a standard in anything except the size of slots in the platen. If these were, for certain sizes of planers, made uniform both as to the width and size of the T for bolt heads, it would save time, annoyance and expense for bolts.

I have had talks with several makers of machine tools, and in every case they were not only willing but anxious to bring about the desired system.

In measuring the different makes of lathes, I have found a great diversity of sizes and tapers. In lathes from twelve different makers, there were twelve different sizes and tapers, nearly all evidently being meant for a taper of one-half inch to the foot. In a good many of them the variation from this was only slight, yet this was, of course, as bad, so far as fitting is concerned, as though the variation was greater. From a close observation I have concluded that one-half-inch taper to the foot will properly hold a drill chuck, milling arbor or center, while either can be backed out with a center key or driver, without much trouble, which is not the case with one having less taper. I would, therefore, recommend the taper of one-half inch to the foot as the taper for all holes in spindles.

In regard to the pitch of thread for the end of a lathe spindle, the Sellers or U. S. S. thread for its corresponding size is all right, and as it has been brought to such a state of perfection in the matter of gauges by the Pratt & Whitney Co., I would recommend that this also be adopted as the standard for lathe spindles. This will give the makers no chance to find fault with gauges not being alike, as all those made by the above-named firm are guaranteed correct. As there is a slight depression in the machine tool industries of the country at the present time, and the tool shops, as a general thing, have more time to devote to any change than they would have were they driven with orders, would this not be the time to inaugurate any new system and have it done and ready for the rush of business that is always sure to follow a slack time?

The above is not written with any intention of having it considered conclusive; but, having seen the matter hinted at in the AMERICAN MACHINIST, I am led to believe that this is is a good time to discuss it. I hope brother machinists will give their views on this subject, as any one who has investigated it in a way to arrive at practical results will certainly do the public a favor by letting it be known.

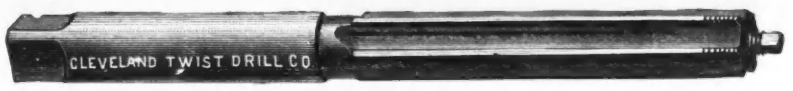


FIG. 1.

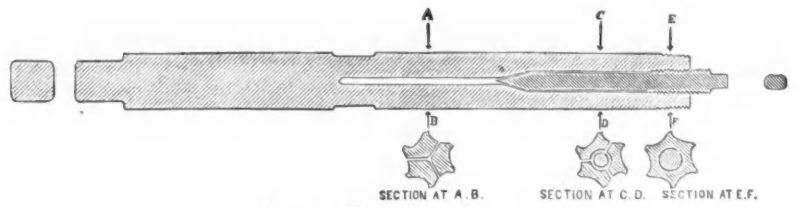


FIG. 2.—EXPANDING REAMER.

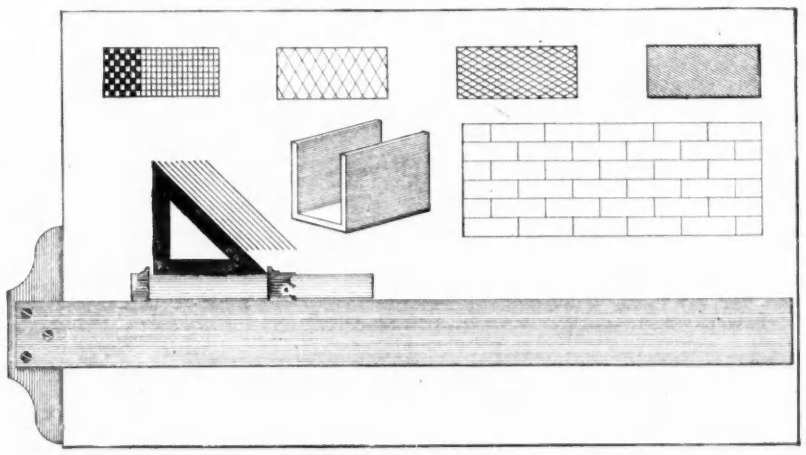
Expanding Reamer.

The engraving represents the expanding reamer made by Cox & Prentiss, Cleveland, Ohio. While the principle upon which this reamer is expanded has been employed for a good many years, the details of construction seem in this case to have been well worked out, making, we should think, a tool that will be appreciated in the machine shop.

In Fig. 1, the general appearance of the reamer is shown, and in Fig. 2, a longitudinal section, and cross sections on different plans. As will be seen, a central hole is drilled from the point to the end back as far as the flutes extend. This hole is counterbored for one-half its length, the enlarged hole terminating in a large taper at the center, longitudinally, of the fluted portion of the reamer. The outer end of this hole is threaded, and a screw plug fitted to it, the end being tapered to fit the tapered part of the hole in the center of the reamer. From the central hole slots extend to the outside of the reamer between the flutes. These flutes do not extend quite to the end of the reamer. The expanding pin or plug is hardened on the end where it fits the taper of the central hole, so as not to cut in use.

It will be readily seen that screwing this plug in will expand the reamer at the center and each way from the center, but that the end being solid will not be affected in size. Screwing the plug back will restore the reamer to its original size.

The end of the reamer shown has a screwed end, for feed, but where preferred they are made with a plain ground end the size of the drilled hole, this end serving as a guide for the reamer. These reamers are made in all sizes from $\frac{1}{4}''$ to $3''$ diameters.



STATE'S SECTION LINER.

State's Section Liner.

The engraving represents a new section liner, for the use of draughtsmen, as well as some of the uses to which it may be put. It consists of a bar provided with two gauge stops, one of which is stationary and the other movable. It is easily adjusted to any triangle, and is operated by holding the liner and angle under the left hand, drawing a line, and then holding the angle and sliding the liner along until the gauge stops. The metallic parts are nickel-plated, and the bar of mahogany is ten inches long. It is made by F. State, Springfield, Ohio.

Men and Machinery on the Mexican Central Railroad.

Mr. R. P. Simpson, division master mechanic of the Mexican Central Railroad, recently visited this office, and gave us some interesting particulars regarding railroad operating in Mexico. The most of the engines they have got are from the Baldwin Works, and the tools in the shops are nearly all from New England. The leading men who carry on the work in all departments of the road are Americans. This includes machinists, engineers, and all the workmen requiring skill or special knowledge. The locomotives burn wood exclusively, but they are built for coal burning, and when arrangements can be carried out to obtain coal, the engines merely need to have the grates changed and other minor alterations made. The climate is delightful all through the region where the Mexican Central runs, and the northern men keep in good health. The unskilled labor is drawn from the native Mexicans. They do he work of rough laboring quite satisfactorily when looked after by overseers. All the laborers in the shops, most of the firemen and brakemen are natives.

Boston and Albany Railway Shops.

By making a visit to the machine shops of the Boston and Albany Railroad last week, we learned that the reports, going the rounds of the Boston papers, that the compound locomotive recently turned out was not working satisfactorily, were not correct. The engine is doing very well, and is pulling the same weight of train as the ordinary engines belonging to the road, but there is not enough data collected yet to show a proper comparison in the matter of economy. The shops belonging to the Boston and Albany Railroad at Boston are very well arranged and the facilities for turning out work are equaled by few railroad or even contract shops. The tools are of the most approved make and all of modern design. A system of exact gauges for work is rigidly adhered to, and many jigs and special tools are used for securing exact reproduction. This company keeps to the old plan of casting the cylinders separate from the saddle, and Mr. Colby, master mechanic, says it has many points that are better than the plan of joining the saddle in the middle. As the cylinders are made interchangeable, the method of casting them independent of the saddle sometimes facilitates repairs. Mr. Colby mentioned a case where an engine came in with a broken cylinder and within ten hours they put a new one in its place and had the engine ready for the road, a feat which could hardly be done with an ordinary locomotive. This company also retains the Mason practice of casting the spring saddle to the driving axle box. Mr. Colby thinks this practice strengthens the top of the box, and they have had no trouble with saddles breaking. In the shop at Boston they have built several of their large standard passenger engines lately. These engines are generally run out twenty miles on a trial trip and then put on to regular passenger service. They have remarkably good luck with their engines, for engine 137 that went out this way has made over 300 runs of 200 miles without missing a trip.

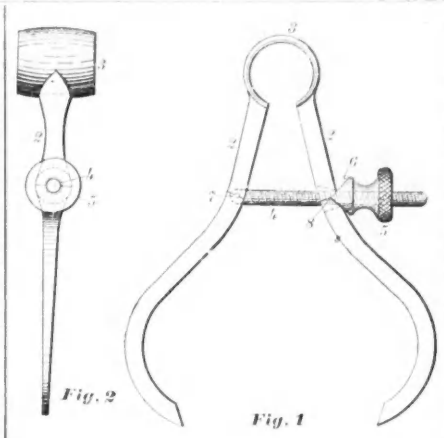
The *Manufacturers' Gazette* has an account of a test of a pair of Corliss engines at the Lancaster Mills, Clinton, Mass. The cylinders are $26'' \times 60''$, revolutions per minute 5,347. The test extended through four days, the average horse power being 670.91, steam pressure 83 lbs. The coal consumption was 1.93 lb. per horse-power per hour, and of combustible 1.77 lb. The diagram as shown, and worked up by Mr. Pray, shows a remarkable approximation to the theoretically perfect diagram.

Improved Calipers.

In spring calipers or dividers, as ordinarily constructed, the different angle of the legs, as they are opened or closed, is constantly changing the bearing of the nut on the leg, or on the plain washer placed underneath it. As a consequence, the nut wears uneven on its face, wears uneven on the thread, and is not evenly and easily adjusted for size. The object of the invention shown in the engravings is to overcome this difficulty. Figs. 1 and 2 represent its application to a pair of spring calipers, and Figs. 3, 4 and 6 detached views of the parts.

It will be seen that in connection with the screw, pivoted in one leg of the caliper, and passing through the enlarged hole in the other, a washer, 6, having one flat side upon which the nut rests, and a knife edge, which rests in a corresponding groove, 8, Fig. 6, across one of the legs, is used. It will be readily understood that in opening or closing the legs the washer will tilt on the knife edge, bearing on the leg in such a way that the face of the nut and the flat face of the washer will always be fair, one with the other, and that the nut will consequently turn smoothly and evenly in whatever position the legs may be.

These calipers are made by J. Stevens & Co., Chicopee Falls, Mass.



Improved Caliper.

Welding Steel to Cast-Iron, and Mending Cracked Castings.

By Thomas D. West.

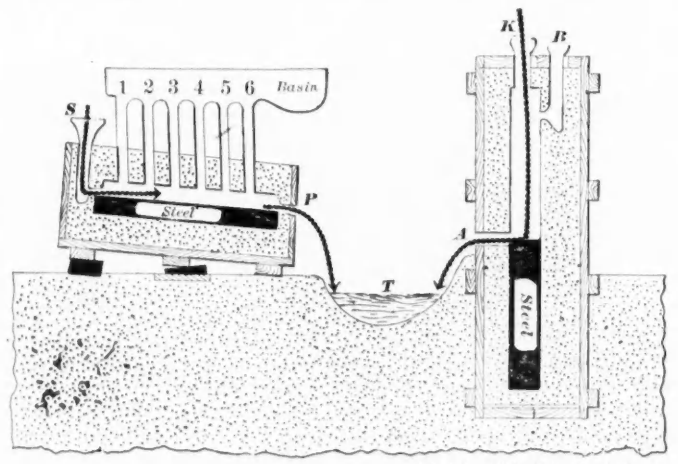
Can wrought iron or steel be united to cast iron? is a question that is sometimes asked. Either can be so united, but in the case of wrought iron the union is so weak that for any practical purpose it is useless. With steel, the point of union will be stronger than the cast iron: at least I obtained such results in experiments upon different brands of steel.

The principle of uniting steel to cast iron is the same as what foundrymen call "burning," and therefore the strength of the union will depend greatly upon the shape to be united, and in the plan adopted for uniting the pieces. In the American Machinist of Jan. 15, 1881, is the writer's first attempt at mechanical literature, in the shape of an article upon "Burning Heavy Castings." This article sets forth the proper plan to adopt in mending, or burning, when its adoption is practicable.

In the cuts shown with this is illustrated the old-fashioned style of burning, and the one which, even at the present day, is quite generally employed. This, in some cases, is excusable, but it is a poor plan to use it for every job that comes along. In the first place, there is much more metal required to burn or make a union; and in the second place the burning or union is seldom so thorough as by the plan illustrated in the upper right hand cut. At *K* the ragged line shows the dropping metal falling direct upon the materials to be united, the fluid metal, by its striking force, soon eating into the solid. By the lower, old-fashioned plan, this eating process is lost, from the fact that the falling metal cannot strike the portion to be burned. If a union is made it has to be caused entirely by the metal's heat and flow, as its falling force counts for nothing. *E* represents the metal flowing into the cavity *F*, and *H* its flowing out. The inlet gate being higher than the outlet, there of course is a current, upon which, mainly, depends the success of the operation.

In jobs of this kind the heat of the metal, length of flow and nature of the work must be carefully considered in deciding as to the strength of the union. Sometimes by testing with a hammer the solidity of the parts may be determined, but as a general thing observance of the points named is relied upon. In the burning of castings invention and judgment are called for, as the exact operations suitable for one job will seldom do for another.

In the engravings are represented four plans suggestive of ideas in the art of burning. Having noticed the two right hand figures, the left hand ones may be referred to. The upper figure represents the burning of large flat surfaces. The reason the mould is inclined is to insure keeping bare the material to be burned or united to the cast iron. In this cut are embodied two plans of gating. At *S* is an inlet gate, placed so as to be opposite the outlet *P*, thereby causing a flow over the entire surface. Were the surface broader than 2″ there should be branch runners cut from the main gate *S*, to assist the spreading of the metal over the entire surface. The basin and gates Nos. 1, 2, 3, 4, 5 and 6, show how the metal may be made to drop directly on the surface. The inclination given the mould should not be more than enough to insure an easy flow.



Uniting Steel to Cast Iron

Mending a Cracked Flange *Old Fashioned Style of Burning*

The cut of the mending of a cracked flange shows a plan that may be applied in various forms. The section represents the actual burning of a cracked flange by Robert Watson, in Todds & Co.'s foundry, Leithwalk, Scotland. The casting was a cylinder, one flange of which was cracked half way around. The casting being placed in about the position shown, the parts around the crack were covered with cores, to prevent the metal from striking or burning other than the portion intended. The cores were made in short sections, and, of course, expressly for the job. In mending the cracks, it was done in sections of from 6″ to 8″ in circumference at a burning. The stream of metal would fall directly into the crack, until it was seen to have cut about $\frac{3}{8}$″ of an opening. After each burning became solid, the cylinder, having a chain around it hitched to the crane, would be rotated into place for the next operation. The arrangement at one end of the portions to be burned was such as to allow the metal to run off, thereby preventing the gathering of a head that would prevent the falling stream from forcibly entering the crack. The point of run-off would be about on a level with the highest point of the circumference. As iron runs level, the surface of the mended portion would present something like the section *R*. This unevenness could to some extent be chipped off, so as to leave a circle as near as could be without doing injury by jarring. As soundness, not symmetry, was the point sought, a little roughness was not objectionable. As to the success of the operation, Mr. Watson says that the cylinder, about two months after the operation, was returned to have the balance of the flange mended, it having cracked while the mended portion remained as sound as any portion of the cylinder.

In burning such a crack, there is a liability that the hot iron will eat its way through and leave the inside, at *M*, rough. To prevent this, cores could be made to the proper circle and firmly rammed up against it, or a wet, loamy facing could be used at this place.

Some may argue that the first burning was the cause of the second crack. It may have been so. And this is a point that should be often considered; for, no doubt, such burning will often cause more or less strains elsewhere. To assist in preventing this, the casting to be burned should be made as hot as practicable, either by placing it in an oven or by surrounding it with fire or hot irons. In this case the casting was not only heated in the oven, but hot scraps of iron were placed upon it. Each crack was mended during the time of one heat, and, as Mr. Watson puts it, he never worked more lively nor sweat so much in his life.

Not long since I received inquiries as to whether and how square bars of steel could be welded, by burning, to cast iron. As already stated, steel and cast iron can be united. I will further explain the upper right-hand cut, as it may present ideas in arranging for the union of many differently shaped articles.

This mould represents the uniting of a piece of steel 1″ square by 12″ long to the same sized piece of cast iron. The process was as follows: A pattern 1″ square by 24″ long is rammed up in a flask. In the bottom board, as shown, is a hole about 2″ in diameter. This admits of $\frac{1}{2}$″ thickness of sand to prevent the hot iron which runs through the 1″ hole from burning the board, and also causes more surety in plugging up, for were the hole surrounded with wood the hot iron would burn itself through, and make the plugging up a blundering job. It would be better in all cases if iron plates were used instead of the wooden bottom boards. In fact, if all the flask were iron it would be best. The mould having been made, the piece of steel is laid in, and the mould closed. Then, after being firmly clamped together, it is suspended in a pit, as shown, and then with about 100 pounds of hot iron start pouring a steady small stream. When within about 25 lbs. of the end slacken the pouring, at which time let the outlet, *A*, be quickly and reliably stopped. After this, quicken the pouring until the mould is filled up. Properly stopping the outlet is very essential, for if not done successfully the first time, it is as injurious to the burning as is slow blundering welding at the blacksmith forge. A good plan for stopping is to securely place a pointed ball of clay on the butt end of a rammer or iron stopper, make sure aim, and firmly hold the hole closed until the metal is set. The gate, *B*, illustrates the use of side inlets should it be desirable to burn more than one piece in the same flask.

The burning of steel is by no means restricted to straight bars. A variety of forms can be united by simply making the moulds the shape of the article wanted, and then placing the steel in its proper place. The gates could be often formed and the mould so placed as to have the hot cast iron flow over most of the exposed surface, to an outlet. In some cases there might be a necessity for more than one outlet, as well as inlet, to which there would be no objection. The point to be aimed at is to have a dead fall upon all exposed parts, and an outlet from same if practicable. With many moulds it would be better were they of dry sand, or loam, as the dropping and washing of much running iron would often cause a green sand mould to produce a rough-skinned job.

Cast iron used for burning purposes should be very soft, and the temperature of the melted iron as high as possible. The amount of iron to use for burning purposes will be regulated by the class of burning to be done. For direct falling upon plain square or round surfaces the following table might in some cases be used:

For a surface of 2″, square or round, use 250 lbs.; 3″ 400 lbs.; 4″ 550 lbs.; 5″ 700 lbs.; 6″ 850 lbs.; 7″ 1,000 lbs. Above 5″, for every additional inch added to the square or diameter add 200 lbs. This, if continued up to a surface of 20″ square or round, would call for 3,600 lbs. of hot iron to accomplish the burning. For square surfaces it might often be well to add 10 per cent. to the given weights. A point that might be well to mention is that the parts to be burned should be chipped, or the scale removed, so as to give the fluid iron the best possible chance to eat into its surface. Any who are interested in this subject will find additional information in the article previously mentioned.

The subject of mending or burning is one well worth studying, and one that generally calls for good judgment and experience. Before a novice undertakes a difficult job of this kind it would be better for him to experiment with unimportant pieces. Burning is a job that seldom can be done twice, on account of the surface losing much of its life or texture. Should the second burning be required the fractured surface should be cut down until good metal is again seen, but in all cases use all precaution towards making the first burning a success.

Tinkering with an Engine.

A well-known builder of fire engines, says the *Millwright and Engineer*, once expressed a determination to inclose his engines in fire and burglar-proof safes, and, after locking them, to destroy the combination, so as to prevent the engineers from meddling with the valve gear. Although the sarcasm may not be deserved by all engineers, it is a lamentable fact that the average stationary engineer has not yet learned to give his engine a chance by letting it alone. Whether his meddlesome disposition is from innate

fiendishness, or whether he believes that the maintenance of his position requires a constant tinkering of the machine in his charge, is a question; but there is no doubting the fact that in nine cases out of ten it would be better for all concerned if he let matters take their natural course. We know of an instance where a new Corliss engine was badly maligned by its owner because the engineer was not content to leave the valves set as the builders designed, and by "monkeying" with the connections had increased the lead of the steam valves from one-sixteenth to five-sixteenths of an inch, and had increased the compression by closing the exhaust valves in the middle of the stroke. And another equally bright specimen of the genus engineer took off the dash-pot connections, because he thought the engine would run easier "if it didn't have to pull them little pumps." The various stationary engineers' associations throughout the country will confer a blessing upon suffering engine-builders, if they will only impress upon the boys the desirability of giving the machine a chance before they go at it with wrench and cold chisel.

The Indicator Diagram.

By F. F. Hemenway.

MEASURING FROM THE DIAGRAM THE STEAM EXPENDED.

The amount of *steam* in the cylinder at any point in the stroke can be measured from the diagram, but unfortunately the water present, that entered the cylinder as steam, cannot be so measured. For this reason the steam actually entering the cylinder cannot be determined by the use of the indicator, but measuring that accounted for by the indicator we know that a *less* quantity could not have been used; in fact we know that more—sometimes much more—is used. In measuring the steam accounted for by the indicator it is generally advisable to select some point in the stroke just previous to the opening of the exhaust valve, when the displacement of the piston in cubic feet up to that point, *plus* the clearance space, multiplied by the weight of a cubic foot of steam of the pressure at the point selected, will give the weight of steam present. From this must be deducted the steam saved by the closing of the exhaust valve before the end of the stroke, the remainder being the steam expended. Instead of determining the steam used per stroke it is better to calculate the amount used per hour. In Fig. 5, which represents a diagram from an engine with a 10″×18″ cylinder at 100 revolutions, 30 spring, a convenient plan is represented. The lines, *x*, *y*, are drawn at a distance equal to the clearance space from each end of the diagram. Measuring the pressure (from vacuum) on line *y*, it is found to be 27.5 lbs., and since *y* is at a distance from the end of the diagram equal to the clearance space, it follows that the space occupied by steam at this point in the stroke is just equal to the piston displacement for a single stroke. The mean net area of the piston is, say, 77 inches, so that the displacement is 77×18=1,386 inches. The number of single strokes per minute is 200, and per hour 200×60=12,000; hence the displacement of the piston per hour is,

$$\frac{12{,}000\times1{,}386}{1{,}728}=9{,}625$$

cubic feet. The weight of a cubic foot of steam of a pressure of 27.5 lbs., is, according to Nystrom's table, .0660 lb., so the weight of steam per hour in the cylinder at this point in the stroke is, 9,625×.0660 =635.25 lbs.

The clearance is 7 per cent. of the displacement, and if we measure at a point in the compression curve where the line, *x*, crosses it, the saving, in cubic feet, by the closing of the exhaust, is equal to 14 per cent. of that accounted for at *y*, or 9625× .14=1347.50 cubic feet per hour. The pressure at this point is 22 lbs., the weight of a cubic foot of steam of that pressure, .0532 lbs., and the steam saved, 1347.50× 0532=71.68 lbs.; consequently the steam

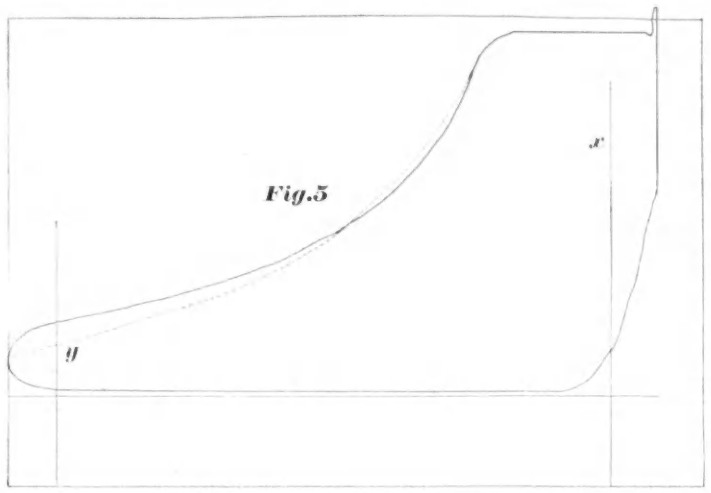


Fig.5

accounted for by the indicator per hour is, 635.25—71.68=563.57 lbs. The mean effective pressure is 29.6 lbs., the piston speed 300 feet per minute and the indicated horse-power,

$$\frac{77\times29.6\times300}{33{,}000}=20.7,$$

so the steam per horse-power per hour, as measured from the diagram, is

$$\frac{563.57}{20.7}=27.2 \text{ lbs.}$$

As a matter of fact the steam actually used was a good deal in excess of this; how much in excess can only be told in any instance by measuring the water supplied to the boiler.

A plan for computing the steam consumption per horse power per hour, without reference to the dimensions of the cylinder or to the clearance, appeared in the American Machinist of Oct. 1, 1881, which, although not universally applicable, may, in the majority of instances, be most conveniently employed.

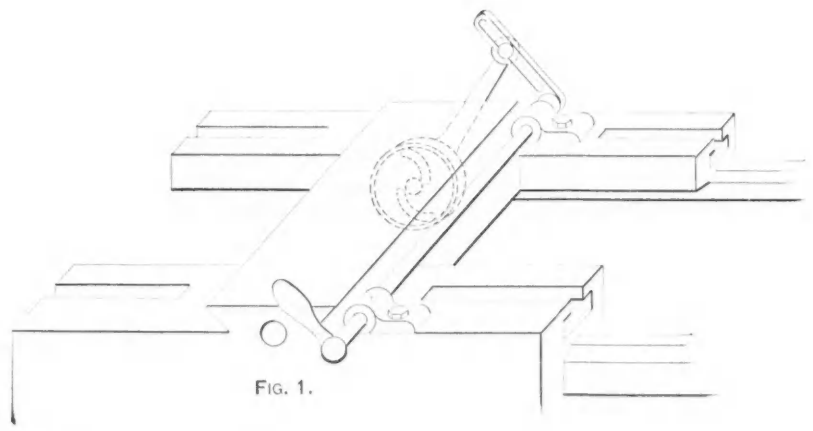


FIG. 1.

It has been previously intimated that it was generally a difficult matter to determine by the diagram how much of the variation between the actual and the theoretical curve was due to condensation and re-evaporation, and how much to leakages by valves and piston. In Fig. 5 it will be noticed that the actual curve falls below the theoretical soon after the steam valve has closed. This is rationally enough accounted for by condensation in the cylinder, the difference in temperature between the walls of the cylinder and the steam being greater than later in the stroke, and hence the conditions favorable for rapid condensation. But if the piston or exhaust valve leak, the leakage will be greatest at this time, owing to the higher pressure of steam, and this may be taken to account for the fall in pressure. The real curve soon rises and crosses the theoretical curve, which may be accounted for by the re-evaporation of water by the excess of heat after the fall in pressure. But this increase of steam may also be accounted for by leakage of the steam valve, which would naturally increase in amount as the pressure fell, while if the piston and exhaust valve, either, or both, leaked, the leakage by them would be correspondingly diminished.

It will be noticed that the pressure rises very rapidly towards the end of the stroke, so much so as to point to the probability of a leaky steam valve, which it may be as well to state, was found to be the case.

It may readily be seen that the leakage of valves and piston may be such as to assist in producing a more nearly correct expansion curve than would result if they were tight, for which reason hasty conclusions as to the economy of an engine should not be drawn from the quality of this curve, nor from the steam accounted for by the indicator.

LETTERS FROM PRACTICAL MEN.

Device for Throwing in Half Nuts—Boring Attachment.

Editor American Machinist:

I send you herewith two sketches of attachments made in our shop to facilitate work on the Putnam lathe.

Fig. 1 represents a simple device for throwing in the half nuts from the apron side of the lathe. All the Putnam lathes I have seen have the screw located in the rear, and the nut is thrown in gear by a lever and eccentric-slot disk, also in the rear. Now, as we have plenty of large pipe to cut and

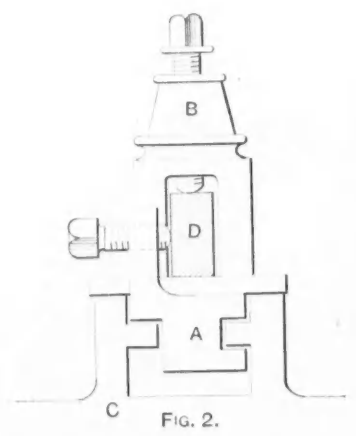


FIG. 2.

chase, always in a hurry, and with no special machines or dies for the purpose, the machinist is under the necessity of waiting till the screw feeds back for a second cut; waltzing over or around the lathe to throw the lever, or keeping a small boy there to do it for him. All these methods being considered objectionable, we devised the apparatus as shown. A rod extends across the carriage, supported by two light brackets. This rod and its handle are located just to clear the slide rest and cross-slide handle, and in this way take but little room, and don't interfere with tail-stock.

At the end of the rod is a slotted arm, in which slides a pin let into the ball end of the disk lever. On throwing the handle at the front, this jumping-jack arrangement brings the nuts in or out of gear in quite a satisfactory manner, and enables the artist to catch his thread with but little loss of time. The cut shows slide rest removed, to avoid too much detail. The rig is a little crude, but not in finish. We took Chordal's advice in that respect, and took time to make the thing look respectable, and we are not sorry for it.

Fig. 2 represents a boring attachment, or brace, also used on the Putnam lathe. On long work it is next to impossible to prevent the tool from springing, and the slide in question, *C*, being long enough for the purpose, we applied fixture *A*, which drops into the jaws of the slide back of the tool post, *B*, and its washer. *A* is tapped and a set screw passes through it, and is brought to bear on the back end of tool, *D*, keeping it up to its work. This rig is also polished up and kept in good order. Its work is quite satisfactory.

Buzz.

Softening Hard Iron Castings.

Editor American Machinist:

I saw in your valuable paper a few weeks ago a recipe for softening hard cast-iron by heating it red-hot and dipping it in water. I thought it was a big thing, very simple and would try it some day, as I often have light castings brought in, sometimes so hard we can neither drill nor file them, and we have to break them up. About three weeks ago a man brought in two carbon-holders of cast-iron to be filed out a little in the hole to make the carbons slip through easily. They were so hard my machinist could do nothing with them. I took them, heated one red-hot, dipped it in water, tried it and it was as hard as ever. Not being discouraged, I thought I would try again. This time I heated it almost to a white heat, dipped it again in water. Taking it out when cold, I could see by its color, being white, that it was harder than ever. I tried it on a file, but it was as hard as glass, and made a wide scratch on the file. I was discouraged, and concluded that the man who wrote that article either did not know how to do it or else he would not tell how it was done. I then thought I would try a way of my own. I heated it red-hot, and then held it in a dark corner, between the water barrel and forge, until I saw the redness of the iron leave it. I then dipped it in water, holding it there till cool. I then tried it with a file, and found it to be soft enough to be filed. I tried the other the same way, with the same result.

One week after this a broken cast-iron handle was brought in to be fixed. It was so hard that the boy who was at work at it said he could not drill it, although the drill had been hardened as hard as the blacksmith could make it. I took it, went to the forge and treated it as before, with the same result. But it was new to the blacksmith, and before I tried it he said, "You will get left on that." "All right," replied I. After softening it, I went over to the same drill the boy had been using, and called him over to see me drill it. I drilled a hole through it with perfect ease. He was surprised and said, "I give in." I was surprised myself at its softness.

Yesterday I was talking to the foreman of a foundry where a great many light castings are made. Although a man fifty years of age, he said it was an entirely new idea to him and he would try it. I am now in my fiftieth year. I went at the machinist trade when only ten years of age in my father's shop in Paterson, N. J. I always liked the trade, have learned a great deal, and am still learning. I have traveled a great deal for the purpose of learning, and have worked in many different shops where the men had to dress their own tools, but I never saw a man soften a hard piece of cast-iron in the way I did.

I remember the way they used to soften small castings for cotton machinery in Danforth Foundry, at Paterson, N. J., thirty-six years ago, was to leave them in a charcoal fire over-night in a furnace, and take them out in the morning.

If this is worth anything to your readers, they are welcome to it. To me it is worth a

great deal, and many thanks to your valuable paper for the cause that led me to try such a valuable experiment. THOS. WRIGLEY.

Chicago, Ill.

Raising the Center of Gravity of High Speed Locomotives.

Editor American Machinist:

The Cincinnati, New Orleans and Texas Pacific R. R. have recently received eight four wheel connected, 18×24 passenger engines from the Baldwin Locomotive Works, built from James Meehan's designs, the general master mechanic of the road. These engines attracted considerable attention while building, and were criticised freely. The peculiarity of the engines consists in raising the center of gravity of the engine—the top of the cylinder part of the boiler being 9′.9″ from the rails, which is 18 to 24 inches higher than ordinarily. The object in this is two-fold—to get in a larger shell and to make an *easier riding* high speed engine. It is generally believed that the lower the center of gravity the steadier the engine, and these engines were consequently predicted by many prominent mechanics to be very unsteady. Mr. Meehan, who several years back had charge of a Mexican road, built and equipped by French capitalists, found that an engine from the Paris and Lyons Road of about the same height as those above mentioned, was the easiest riding engine on the road and took certain short curves on that road at fifty miles per hour much smoother than engines in which the boiler was lower. In my own experience on an Ohio road, having several inside connected engines in which the boiler was much higher than other outside connected engines, the former engines were found at high speed to be much easier, and to have less of that sudden lurch so perceptible on the lower engines on striking a sharp curve. It is a well known fact that inside connected engines are much easier riding engines than outside connected, and this has generally been attributed to the lesser distance between the centers of the cylinders, but it is undoubtedly true that the raising of the center of gravity has much to do with it. On trial of the eight engines of the Cincinnati, New Orleans and Texas Pacific R. R. they exhibited, as Mr. Meehan predicted, a much steadier action than the other engines. This road probably runs as fast trains as any in the country, and curves at which the other engines are slacked up at are freely run at full speed with the new engines. On one of the regular passenger trains—four six wheel truck passenger cars and two baggage cars, a distance of 20 miles has been made by these new engines in 19¼ minutes; and at this speed many practical railroad men who have ridden on these engines have owned to the remarkable steadiness and apparent ease of the working of the engine, put its speed at 50 miles per hour, until convinced by the watch when the distance was covered.

The rods—main and side rods—have solid ends with brass bushings, excepting the forward ends of the main rods. The appearance of the engines is also greatly improved by the high boiler, giving a noble and grand effect. Considerable trouble has been experienced on this road with the breaking of steel crank pins, which are replaced with hammered wrought iron pins case hardened, which give no trouble whatever. A committee of experts have recently examined the performance of this company's engines as to "smoke burning," and have pronounced them the best in the country. Mr. Meehan's device for this purpose is the brick arch and extension smoke box, which give splendid results, and should be used in connection with each other, as neither alone proves satisfactory. Roads using the extension smoke box alone frequently condemn it as it fills quickly with sparks, while with the brick arch in combination no trouble is found in running the engines 200 miles without cleaning out the smoke arch. FRANK C. SMITH.

Laws for Licensing Engineers.

Editor American Machinist:

I have watched with interest the efforts that have been made to oblige steam users in Philadelphia to employ none but licensed engineers, and I was greatly surprised and disappointed at the position taken by the committee of the Franklin Institute that reported on the matter. Although many of the members of the Franklin Institute are probably owners of steam boilers, I had hoped that they would recognize the necessity of having competent men in charge. As to their reasons against asking for such a law: A man's knowledge of the machine under his care can easily be ascertained by a competent inspector, and should a passed man not prove sober, watchful and diligent, a steam user would be under no greater obligations to keep him than under the existing system; and the fear that his license may be revoked for misconduct has a good effect on many men. There is not much fear of an incompetent candidate mastering the correct answers, for the information implied in the answers which a competent inspector will ask implies sufficient knowledge to enable a man to take charge of any stationary engine. Any change of law that will have a tendency to induce those in charge of steam boilers to study out the principles underlying the application of steam will have a beneficial effect upon the men, and those they work for will be the gainers by receiving better service for the money they pay out. Had Philadelphia moved in the direction of mechanical progress in this matter, other cities would have followed suit, and benefit would have resulted to the whole country.

U. S. LICENSED ENGINEER.

Referring to the article entitled "London Smoke," written for us by J. C. Hoadley, *The Locomotive*, published by the Hartford Boiler Insurance Co., says:

The article on "London Smoke" in the *American Machinist* of Dec. 16th, is one of the most sensible lectures on the subject of smoke that we have read for some time. We would advise every one who has anything to do with coal burning to preserve a copy of it and read it carefully and often.

Such paragraphs as the writer takes for his text are quite too common, and when one gets started, about every paper in the country is sure to copy it, and it thus gets a very extensive circulation, and many people who have the foolish habit of believing everything they see "in print," take them for gospel truth, and they become powerful promoters of the sale and use of all kinds of patented smoke-consuming, fuel-economizing, money and labor-saving—humbugs. This is especially true of boilers and boiler appliances.

After all the inventions that have been made and tried, and all the printer's ink and mendacity that have been used to push their sale and use, the hard fact remains to stare us in the face, that the best economy is attained, and the least smoke made when we have a boiler of simple construction, set plainly and substantially, with a *good amount of heating surface to each square foot of grate surface*, a plain, straight grate bar with about 50 per cent. air space, and a *good chimney*, with as few bends as possible between it and the grate. When a man has these, and he can very easily obtain them without paying a royalty to any one, he has the best and most economical steam plant that has yet been devised.

Decrying the Prison-Contract Vote.

If the State-prison contractors could secure the aid of every influential newspaper in the State of New York, they might perhaps persuade a certain class of readers, who believe everything they read in their favorite daily, that the saccharine qualities of sugar and vinegar are really very much alike. Fortunately, however, they don't direct the course of every daily paper on the contract question. Recently, Mr. Perry, who has the stove contract in Sing-Sing prison, issued a pamphlet, trying to convince the citizens of this State that the expression of their will on the contract system at the ballot-box last fall is not entitled to much weight in settling the question. The *Evening Herald*, of Syracuse, one of the strongest and best supported papers in Central New York, sifts out the fallacies in that pamphlet so well that we reproduce, below, their editorial on the subject:

Mr. John S. Perry, of Albany, a gentleman whose name is inseparably associated with the idea of fat contracts, and whose interest in the dear public is largely due to the fact that he has lived upon the dear public for years, has published a pamphlet to show that the majority of nearly one hundred and forty thousand votes cast last November "for the proposition to abolish contract labor from the State prisons" had really no significance.

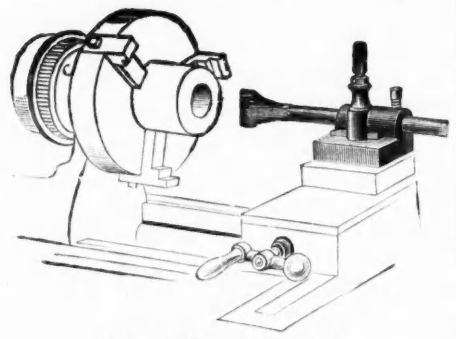
The first point he makes is that more than two hundred thousand people who voted for one candidate or another for Comptroller cast no ballot on the prison-contract system. This argument is as brilliant as any of Mr. Perry's devising. When we examine the election returns of the State for 1879 and 1880, we find that the total vote for Governor in 1879 was 901,535, and the total vote for President in 1880 was 1,103,945. Here is a difference of more than two hundred thousand votes, or about twenty-two per centum of the vote of 1879—indicating, according to Mr. Perry's truly original logic, either that the questions involved in the most notable triangular fight for the Governorship on record were not generally understood, or that ballots were not supplied to the voters.

His second point is that the form of the ballots was defective, and hence that many who wanted to vote in favor of continuing the contract system voted unwittingly for its abolition. Perhaps Mr. Perry may be able to find a language better calculated than English to express the ideas of an English-speaking people; when he does, we trust he will publish his discovery without delay. The prison-contract ballots were printed in grammatical English, in the plainest possible terms, in black ink, in large, fair type, and on white paper. If anybody misunderstood the nature of his vote he had only himself to blame, for, if he couldn't read, he could at least appeal for assistance to somebody better educated than he. And is it not a little odd, in view of Mr. Perry's plea that the anti-contract vote was drawn from the ignorant class of voters, that all the blunders in reading plain English seem to have been made by friends of the contract system?

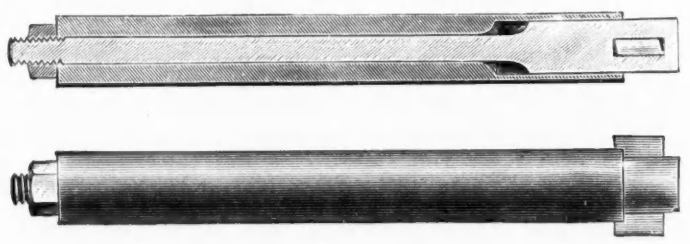
The third point is, that "in the cities and large villages there was such a systematic and wholesale destruction of the ballots 'against the proposition,' that at hundreds of polling places, there is reason to believe, none of them could be found." Now, to start with, we have merely the unsupported statement of an interested party, made in a guarded way, for this assumption. But, even if we had evidence which was worth anything, the argument would be ridiculous when we observed that it is applied to "the cities and large villages." In cities and large villages there are always presses and type which can be engaged at a moment's notice to print ballots enough to repair any deficit. If Mr. Perry's charge is to receive any credit whatever among thinking people, he must change its location, and make it affect the little bits of villages and country cross-roads—not the abodes of the more advanced civilization.

The fourth and fifth points have reference to the reluctance of politicians to peddle the pro-contract tickets at the polls, and the alleged intimidation of voters. How very strange it is that Mr. Perry should have just awakened to a realization that intimidation is used to affect votes! If he will come to Syracuse we will introduce him to any number of political magnates who, as each election approaches, proceed to count on their fingers the employers they have seen: Smith, with twenty men in his joiners' shop; Jones with fifty men in his mill; Robinson, with two hundred men engaged on his big contract jobs, and so on through the list. The question is never raised, whether each of Smith's carpenters will vote as Smith wishes, or whether all of Robinson's laborers will cast the ballots distributed among them by their employer. The men are supposed to know what is expected of them, and what will happen to them if they do not meet these expectations. If Mr. Perry wants to discuss the subject of intimidation, let him do so. But let us have the inquiry full and fair, covering both sides, and then let us ask ourselves whether the recent exhibitions of strength which the workingmen are making through their organizations do more than balance the indignities they have suffered for years, when their employers have offered them with one hand a loaf of bread, and with the other a party ticket.

When Mr. Perry can make a better showing for his side of the prison contract controversy, we advise him to get out another pamphlet. Meanwhile, for his own sake, he would do well to hold his peace and save himself the ridicule which is excited by such literary buffoonery as his present effort.



BAKER'S BORING CUTTERS.



BAKER'S BORING BAR.

Baker's Boring Cutters, and Boring Bar.

These cutters are of solid steel with two cutting edges cutting on two sides of the hole. They are of standard sizes, and readily used on the lathe, boring long holes straight or any number of holes of practically uniform size. They are as readily ground as a drill.

The boring bar is intended for boring holes of greater depth and diameter—up to 6 inches or larger. The manner of holding the cutter, which is plainly shown, avoids the use of a key and provides for setting it accurately. The bar can be used the full length out from the tool post, for long holes, or the cutter end can be brought close to the tool post for short holes. The cutters are made to standard sizes.

These tools are made by G. W. Baker & Co., Wilmington, Del.

Reorganization in the Rogers Locomotive Works.

We learn that the Rogers Locomotive Works, Paterson, N. J., have been closed pending an entire reorganization in the operative management of the establishment. These works have not been suffering greatly for want of business, for the company have received large orders that will keep them busy for some time; but the decreased prices paid for locomotives demands retrenchment, and the most available method is improving the means of operating. It is not surprising that the principal owner of this establishment should move in the direction of reorganization, for the works were badly managed. A visitor to the different locomotive works in Paterson could not fail to notice how conspicuous was the want of system in the Rogers Works when compared with that of its smaller neighbors. The race of competition is now so keen in locomotive building, and the demand for interchangeability of parts is so exacting, that well-designed special tools must be employed largely in producing the different parts of locomotives, and a rigid system of labor subdivision must be followed to get out work rapidly. Some years ago the Rogers Works adopted the template system of producing work, and many new and special tools were put into the shops; but these facilities have not been applied to proper advantage, for want of close, personal supervision. The impression that a visitor received from a walk round the works was that the facilities for doing exact work were good, but that no one was interested in how it was got out. No work carried on in a slip-shod way can be prosperous, and we are satisfied that it will be better for the owners, for the men connected with the works, and for the interests of Paterson that a reorganization in the Rogers Locomotive Works should be effected.

Railroad Mechanical Personals.

Mr. Ross Kells, superintendent of motive power of the New York and New England Railroad, has resigned, and accepted an engagement with the French Smoke Consumer Company. W. H. Tomlinson, chief draughtsman of the Cincinnati, New Orleans and Texas Pacific Railroad, has been promoted to the position of assistant superintendent of motive power of the same road, with headquarters at Ludlow, O. J. W. Fowle has been appointed master mechanic of the New Orleans and Meridian division of the above road, with headquarters at Meridian.

Chicago Railroad Shop Notes.

The Chicago & Northwestern Railroad Company are building four new dining cars of the unusual length of 64 feet. They have at one end double doors, one for the kitchen, the other for passengers. The cars are very conveniently arranged. The ice-closets, pantries, heaters, etc., are all separated from the car proper. They will seat 50 persons, and will cost about $10,000 each. In the locomotive department four new passenger engines, 18x24, are under way. A new feature about them is the doing away with cross-stays between the crown bars, making the crown bar itself act as such a stay.

The Illinois Central Railroad Company are building 14 new locomotives of the double end type, for suburban traffic, and three moguls for road traffic.

Running a Lathe.

BY FRANK H. RICHARDS.

SIXTH PAPER.

I have a home-made, independent four-jawed chuck that suits me pretty well; and now, when I come to put it upon the spindle, I may call attention to a wrinkle that I got—one of many—from Mr. Geo. W. Richardson, of the Consolidated Safety Valve Co., Boston. How many of us have got into trouble at some time or other by having a screw "seize" in a nut on account of a chip or bit of dirt—"matter out of place"—getting in between the threads. I have seen more than one chuck or face plate stuck in that way, and only removed after much sweating and swearing, to leave upon the spindle its mark of inneffaceable mutilation. "What fools we machinists be!" A thread, as cut, always ends with a long taper to the first thread, and what a chance and invitation

FIG. 1.

FIG. 2.

this taper thread offers for any loafing foreign substance to sneak in—confound a sneak, anyway!—and make trouble. You and I, respected reader, have often filed the end of a square thread to a beautiful slant like this—Fig. 1. We can imagine the delight with which an impish chip would lie upon his back upon the comfortable slope of the advancing front of this thread and brace his heels against the bottom of the thread in the nut, and try to block the concern. Now, if instead of this the end of the thread were cut off perfectly square and full (Fig. 2), the advancing front of it would act as a scraper: the threads would be kept clean, and all trouble would be prevented. This is the one place in the world where "bangs" are beautiful. But on the lathe spindle the abrupt end to the thread might make it a little uncomfortable to enter, so if we leave the taper end of the thread in its natural shape and cut a deep, square notch in it the entire section of the thread just at the point where it attains its full size (Fig. 3), this notch will serve as a pocket to catch anything that may come in the way. To put on a chuck or face plate, we stop the spindle with this notch uppermost, and as we screw the chuck on, its weight resting upon the top of the thread, this first thread of the spindle will scrape out the internal thread quite clean.

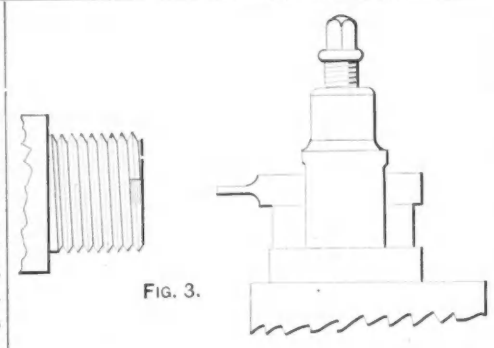


FIG. 3.

In cutting out this notch don't try to do it by hand. You may be ever so careful, and then you won't make a good job of it. Just set a little square-nosed tool in the tool post, made of a bit of, say, $\frac{5}{8}$ square steel, and ground to cut endwise, with a little clearance. Then fastening your lathe spindle in proper position, the cutting is done by moving the rest back and forth by hand, and slowly feeding the tool in toward the center, until the botton of the thread is reached. Then the spindle may be rolled a little and another chip taken, two or three successive chips giving the notch width enough.

It is, I suppose, proper to confess that I have never used this "kink," but I see no possible objection to it, and I think the pocket must be good to allow little chips and bits of dirt to drop in. No device can supersede carefulness and cleanliness in the workman. Chucks and face plates, when not in use, should be so placed or protected that chips or dirt can not possibly get into the threads.

I put together here a set of centers for a lathe, and offer a few running remarks about them. I would have at least two pairs of regular centers; one pair I would keep as accurate as possible, the other pair I would not be quite so particular about. Of course, I should be very remiss in my duty if I did not charge the neophyte latheman, with my longest face and in my most solemn tones, never, never, never to begin work upon a piece until he has carefully drilled his centers; and yet it is a fact that in jobbing and repair work, little five-minute jobs will come along that it will not pay and that it is not necessary to drill nice centers in. And, besides that, many jobs come along from the blacksmith that we are not ready to center until we have cut off and squared them approximately to the right length. If the blacksmith forges anything with a collar on, he will usually allow, say, $\frac{1}{8}''$ on each side of the collar to clean it up, and then he will measure from the collar to the end of the piece and allow another $\frac{1}{8}''$ for squaring up. As the $\frac{1}{8}''$ allowed is often $\frac{1}{4}''$, and in addition to this, as he measures his work while hot and allows 1″ to the foot for shrinkage, I have seen such pieces come $\frac{3}{4}''$ too long (I have no such trouble now-a-days), and we are not ready to center such things permanently until we have cut off this superfluous length. I would often do this upon centers made with a center punch, and I would keep a special lathe center for such abuse. I would have the live center as short as possible. The blanks that come with the lathe are usually of the same length, and generously long, and in turning them up with conscientious thoughtlessness we save all the stock we can. Now if, instead of this, we cut the live center 1″ or so shorter than the other, it will spring less from the leverage of the dog, and in course of time, as the tail center wears, it will still get to be the longer of the two.

FIG. 4.

FIG. 5.

A very long center is often called for in the vicissitudes of miscellaneous lathe work to accommodate pieces that have projecting ends.

A center in the tail stock turned down small, say $\frac{3}{8}''$ or $\frac{1}{2}''$, Fig. 4, will be found quite a convenience in turning small work.

A center with a notch in, Fig. 5, to allow a side tool to face clear into the center is sometimes used. I have not felt the need of it, and have had no experience with it, and think it is an unnecessary refinement. I would certainly learn how to face up an end neatly without it, and so be independent of it when not accessible.

The center, Fig. 6, besides being generally useful, will serve at least three specific purposes: First, it is made for putting chucks and face-plates upon the spindle. The head should, therefore, just fit easily into the hole in the chuck, and, that the weight of the chuck may rest upon the hub without injury to the thread, the points of the threads in the chuck should not be quite sharp. It will be found much easier and safer to put on a chuck when using this center than without it. This center may often be used in the tail spindle for drilling against. Thirdly, it

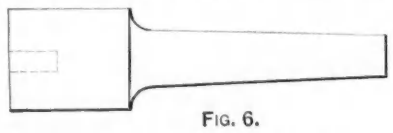


FIG. 6.

should have a true hole bored in it, say, $\frac{1}{2}''$ diameter and 1″ deep, to take the ends of drills and reamers for chuck work. However prevalent the practice may be, it is still incorrect and reprehensible, not to say dangerous, to use drills and reamers for chuck work upon a common conical center. The leverage of the wrench or hook, or whatever contrivance we have to keep the tool from turning, tends to crowd it off the center laterally and jam it into the hole untruly, and perhaps jerk the work out of the lathe. So, in making taps and reamers, and such articles, to be used upon work in the chuck, they should be made with "tits" upon the end to fit into a socket like this, and then they can be used without danger of prying off sideways, or of crowding into the work faster than desired.

It may sometimes, but rarely, be preferable to have a hole in the end of the tap or reamer or drill, instead of a "tit" upon it, and in

FIG. 7.

that case the center, Fig. 7, comes into use. I may mention that I have sometimes, when drilling and tapping holes in the chuck, used a twist drill in a true drill chuck in the tail spindle, and then made a special tap to use with it, the tap having a hole drilled into the end of it large enough to just slip easily over the drill. Then, having drilled a hole, the drill serves as a center for the tap, and the whole operation is carried on and repeated indefinitely without losing time in changing the drill.

A little plug, kept to insert in the hole of Fig. 6, and projecting sufficiently from it, would enable us to dispense with Fig. 7.

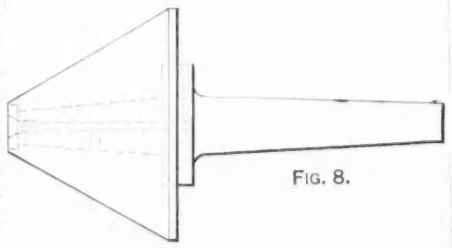


FIG. 8.

A pair of large centers for pipe work will be found very necessary. The live center will be used much less than the dead center, as much of the work of that character will be held in the chuck. Where a live center is needed, the head may be made solid with the stem, but the dead center should be brought to life. The revolving center, Fig. 8, is, for the tail-stock, far preferable to the solid center, and should be more generally used. The head may be made of iron and case-hardened; the spindle should certainly be made of steel, both for stiffness and wear. An oil-hole is provided by drilling into the end of the spindle as far as the collar, and then drilling down through the collar to meet it, and another hole is drilled into it about half-way to the point to distribute the oil where needed. The screw in the end which fastens the retaining collar serves to plug the drill hole and keep in the oil. The head where it comes against the collar is recessed to allow the insertion of a bit of rawhide. For a few such places as this, and especially behind the end of the live spindle of lathe, I have never found anything as good as rawhide. I have lately been trying "vulcanized fiber" in similar places with satisfactory results.

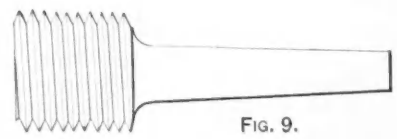


FIG. 9.

Fig. 9 is another center which may be preferred for putting the chuck on the spindle. The thread is cut to fit the chuck easily and run freely clear through it. To mount the chuck this center is screwed into it and the stem inserted in the center hole of the spindle and pushed home. The stem and the taper hole must of course be perfectly clean to allow the center to go in to its proper length, and also the center must be turned around to some suitable mark that will bring its thread to lead correctly with the thread of the spindle. Then the chuck can be screwed on from this center to the thread of the spindle and the center can then be removed. It will not be easy to remove it without injury except the lathe have a hollow spindle. By the use of this center all danger of injury to the points of the threads in the chuck is avoided, which is not quite true with the plain plug, Fig. 6. When a chuck or face plate is not in use this center may be kept in the hole of it and prevent the entrance of chips.

Another center should be provided with a threaded end and collar, the exact counterpart of the end of the live spindle, Fig. 3. This will be frequently found useful, enabling us to mount upon the tail stock face plates or small chucks fitted to the live spindle.

Among our centers a good drill chuck must not be forgotten. The Beach chuck has never been superseded. It is well made and serviceable not only for drills but for holding small work of various kinds and for such uses it is the truest of all "universal" chucks. It will not hold twist drills tight enough, and if we persist in using them in it without some additional help in driving we shall soon wear the dogs out of truth, and seriously impair its usefulness. I have been looking for, and still expect to see some day upon the market, straight shank long drills with three small flats ground upon them perfectly true to enable chucks like the Beach to hold them securely. The additional cost of drills thus improved could be but slight, and would greatly enhance the value of what is otherwise the best drill chuck.

Test of the Otto Gas Engine.

Messrs. Morgan Brooks & J. E. Steward, of the Stevens Institute of Technology, Hoboken, N. J., recently made a series of carefully recorded experiments with an Otto gas engine for the purpose of determining the actual efficiency of the machine, and to obtain accurate data of the cause of waste. The data obtained were used for making a comparison of the actual with the thermodynamic performance of the gas engine: they also enabled the investigators to show the relative economy of gas, steam, and hot air engines. Several new facts were demonstrated in regard to the gas engine. The most economical proportion of gas to air was determined. When the engine was working with the gas supply throttled the engine sustained a loss of effective horse-power, which showed the disadvantage of using too little gas. The heat of the gas used with this engine was expended as follows: $17\frac{1}{2}$ per cent. as indicated work including useful work and friction; 15 per cent. in the hot gases expelled by the exhaust; 52 per cent. absorbed by the water jacket, and $15\frac{1}{2}$ per cent. in radiation, etc. The conclusion arrived at as to the cost per hour per horse-power was with the gas engine, $8\frac{3}{4}$ cents; with the steam engine, $3\frac{1}{2}$ cents, and with the hot air engine, 4 cents. For intermittent work the gas engine would be considerably more economical than the figures indicated.

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NEW YORK, MARCH 1, 1884.

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Locomotive Building in the United States.

The business of locomotive building is singularly depressed at present, considering the condition of other mechanical industries. During the year 1882 there was an abnormal demand for locomotives, and all the works were overstocked with orders, each railroad company seeming determined to increase its equipment of engines at that time. The middle of 1883 found the boom passed and orders getting scarce, and by the end of the year the outlook for work became depressing. The output of locomotives during 1883 represented a good business for all our locomotive works, but the indications are that they will not be required to produce nearly the same volume of work this year.

By correspondence with the different locomotive builders, we have learned that during 1883 seven of the leading works turned out 1,346 locomotives. An examination of the list indicates that the percentage of heavy engines called for is steadily increasing. Till within the last five years many railroad managers and master mechanics entertained strong prejudices against locomotives with more than eight wheels, but the increased utility of heavy engines for freight service has forced the many-wheeled types into favor. We now find that about 40 per cent. of the locomotives built last year for American railroads were Moguls, or consolidation, engines. Out of the 1,346 locomotives built in the leading shops, about 200 were for export. The tendency in all directions is towards greater weight of engines, and it is hard to say when the limit will be reached. We calculate that the builders who did not wish to mention their output of locomotives, and those built in railroad shops, will raise the list to about 2,000 locomotives built in the United States during last year, representing about 100,000 tons of material and a money value of $20,000,000.

The depression in locomotive building business does not originate from the railroads throughout the country being overstocked with motive power. Many railroads are miserably equipped with engines, and ought to be renewing when the prices are low, but the managers are prevented from doing this through the manipulations of the stock market. Not a few railroads have entered upon a system of operating which will lead to disaster in a short time. They are running their rolling stock without keeping it up by proper repairs or renewals—a course that will go on till a general breaking down occurs, when a receiver will be the necessary physician.

"Self-Supporting" Prisons.

Reports have occasionally been issued by the New York State Superintendent of Prisons of the monthly earnings and expenses of the three prisons belonging to the State. In these reports the earnings slightly overbalance the expenses. As an aid to understanding how this result (which is the strongest argument in favor of the contract system) is made to appear, attention may be called to the results of a fire which recently destroyed the Minnesota State prison at Stillwater. A company carried on the manufacture of cars in that prison with the contract labor of the prisoners. An interview with Senator Sabin, president of the company, just after the fire, was published in the daily papers. It ran thus:

"He has received private despatches to the effect that the loss by the fire will not exceed $50,000, all of which falls on the State. The total loss sustained by the car company is in the way of office furniture, and will not exceed $1,000."

Minnesota, like New York, is so accommodating to the prison contractors as to furnish them *free shops, machinery and power.* What machine shop could not show a surplus of earnings over expenses if no account is made of such expenses as rent, cost of equipment, taxes, insurance, power, lighting, and heating? The cost of shops at Stillwater is small compared with the cost of the large shops at Sing Sing. Let the superintendent of prisons subtract from earnings the running expenses of the shops as paid by the State, and interest on the plant owned and furnished free by the State, in his next report. The balance will then be on the other side. The people have been humbugged long enough by false reports that the prisons are "self-supporting."

Is the Inventor Notional?

Often the inventor—particularly of mechanical devices—is accused of being notional, simply because he comprehends upon what small things the successful working of his invention may hinge. Nearly every one who has had occasion to investigate some common enough mechanical subject, has been surprised at how much he has been able to learn of things that in a general way he was entirely familiar with. The inventor may be supposed to have gone into the detail of his invention in a way that no one else is interested in doing, and what are set down as his whims may quite generally be found to be evidence of his superior knowledge of the subject. No invention is fairly condemned unless all the plans of the inventor have been fairly carried out, and unfortunately these plans cannot always be detailed on paper.

It is a myth of the Patent Office that the descriptive matter of a patent, together with the drawings, will enable those "skilled in the art" to make what the inventor describes, or tries to describe. In fact, in many instances it will do nothing of the kind, no matter how hard the inventor may try to make everything plain. There are some things, in mechanics as well as elsewhere, that cannot be described—at least not without the invention of a new language, or the discovery of a new sense.

Just why some machine or mechanical arrangement will work satisfactorily in one locality and fail to give satisfaction in another, is not always clear on the surface, but, of course, would be manifest on sufficient investigation. On two railroads, the shops of which were scarcely more than a mile apart, efforts were made, some years since to use a special kind of piston packing. Upon one road the effort was entirely successful, that packing being exclusively used at the present time. Upon the other road equally strong efforts were made, but after trying for a year or two to overcome the difficulties in the way, the attempt was abandoned. The effect, so far as these two roads are concerned, is the same as if this packing would work satisfactorily on one road and unsatisfactorily on the other; something, of course, that is not true, but that serves all the purposes of a fact.

Inventors may be called critical, but not notional above others. Nothing is more discouraging than for one to know that his invention will work satisfactorily if properly handled, but for the want of that is condemned. Unfortunately, he cannot lend his eyes for others to see through, and his senses by which to interpret the sight. Knowing how much depends upon first impressions, nothing is more in accordance with the exercise of good judgment and sound business principles than that he should insist on the little things he sees, but which others do not. Many promising inventions are put one side through the efforts of others to improve the plans of the inventor. Before doing this, it should be satisfactorily demonstrated that they need improving.

The United States Patent Office has not only always been self-sustaining, but has at the present time a large cash balance on hand. As it is, or ought to be, contrary to the policy of the Government to make money out of a class that, as much as any, contributes to the general prosperity, there is one way in which a part of this unexpended balance could be used to the benefit of the class who contributed it, and incidentally for the benefit of every one. That is, by publishing classified lists of the more important patents, with their dates and names of patentees, so that any one interested could find what patents had been issued, and could, if he desired, put himself in the way of obtaining copies. This would often save the inventor much expense and time, and save the issuing of useless patents. It would also enable the purchaser of patents and patented devices to see what patents relating to the same had been previously issued, and put him in the way of making investigations in his interest. The records of the Patent Office have become so voluminous that searching through the mass of irrelevant matter is a task almost too great to be undertaken, and anything that makes it easier for those interested to investigate in the direction of their interests would be an undoubted benefit.

Literary Notes.

A TREATISE ON THE COMPOUND STEAM ENGINE. In two parts. Part I.—By John Turnbull, Jr., with Method of Finding the Relative Cylinder Volume. Revised, with additions. Part II.—Graphical and Analytical Treatment. Illustrated with Diagrams, Tables, &c.; including Rotative and Pumping Non-Rotative Engines. By S. W. Robinson, C. E., Professor of Mechanical Engineering, Ohio State University. New York: D. Van Nostrand, Publisher, 23 Murray and 27 Warren streets. Price, 50 cents.

As the interest in compound engines is manifestly increasing, students and readers will generally be interested in this book, the low price of which places it within the reach of all. Many readers are already familiar with Mr. Turnbull's reasoning as to the economy of the compound engine, the plainness with which his statements are made commending him alike to the critical and general reader. Useful tables are given in this part of the work, and indicator diagrams illustrating practice. This part of the work treats only of the compound engine without receiver, and with cut-off only on the high pressure cylinder. In part second Prof. Robinson treats the subject much more comprehensively, and more in accordance with modern practice. In this part of the work the compound engine is considered with and without receiver, the effect of clearance, cut-off on one or both cylinders, re-heating, super-heating, and a variety of other conditions that will suggest themselves to the designer, receive proper attention.

THE RELATIVE PROPORTIONS OF THE STEAM ENGINE. Being a Rational and Practical Discussion of the Dimensions of every Detail of the Steam Engine By William Dennis Marks, Whitney Professor of Dynamical Engineering in the University of Pennsylvania. Second Edition, Revised and Enlarged. Philadelphia: J. B. Lippincott & Co. Price $2.

The first edition of this work having been favorably received, the author has revised and added to the matter to make it more complete. The argument is good, and the formulas are reduced to as simple forms as is practicable in a work of this character. It would seem to be a very convenient book for those engaged in designing and constructing steam engines, who have a fair knowledge of mathematics.

The Order of Railway Conductors have commenced publishing a monthly magazine with the above title to represent the interests of their order. The first number, which is dated January, is before us, and it is a very handsome and interesting magazine. The articles are carefully prepared, and the selections are judiciously made, the editor being evidently actuated with the desire to give the subscribers a treat in the way of interesting reading. Mr. C. S. Wheaton, Elmira, N. Y., the Grand Chief Conductor of the Order, is editor, and Mr. W. P. Daniels, Cedar Rapids, Iowa, Grand Secretary, is business manager. We know Mr. Daniels to be one of the most energetic railroad men in Iowa, and his business ability will do much towards assuring success to the *Conductors' Monthly.*

The *Baltimore Manufacturer's Record* is one of the most enterprising newspapers devoted to Southern industrial interests. It gives every week a large amount of information about Southern railroad, mining, manufacturing and building operations; also market reports and intelligent discussion of commercial matters.

QUESTIONS AND ANSWERS.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials, nor location will be published.

(83) D. N., Mt. Forest, Ont., asks: Can I learn the elements of the machinist trade in a reaper and mower shop? *A.*—Yes.

(84) P. O., New York, asks: What is the simplest and quickest way to restore tarnished electrotypes to their original color? *A.*—We do not know of any quicker agent for restoring copper to its original color than muriatic acid.

(85) Apprentice, Providence, R. I., asks questions about the teeth of gear wheels, to which he will find answers by studying articles on this subject in the AMERICAN MACHINIST of August 7, 14, and 21, 1880; December 29, 1883, and Feb. 16, 1884.

(86) M. M., Mt. Vernon, O., asks: Will you tell me how to graduate a circle so as to get the degrees exactly correct? I know how to do it on planer centers. *A.*—If you require exact graduations, you should get it graduated on a dividing or graduating machine. You can graduate it approximately on a gear-cutting machine.

(87) Gath, Huntington, W. Va., asks: 1. What is the rule for determining the length of locomotive links? *A.*—There is no rule. 2. What is the longest railroad in the world? *A.*—The Chicago, Milwaukee, and St. Paul Railroad Company operate 4,256 miles of road, which we believe is more than is owned by any other corporation in the world.

(88) J. G. H., Bay City, Mich., asks: What is the best and most durable preparation for painting smoke-stacks that are exposed to great heat? *A.*—We have found melted tallow, with enough Japan varnish dropped into it to darken it, makes the most durable application for smoke-stacks. Common black asphaltum varnish does very well. Many locomotive firemen use boiled linseed oil and lamp-black.

(89) T. J. J., Harrisburg, Pa., asks: What would be the size of ports and bridges, and travel of valve, also speed and power, of an 8″x10″ engine, the boiler pressure being 75 lbs.? *A.*—You can make the speed what you like, and proportion the ports and valve accordingly; say, at 250 revolutions you can make the steam ports 7″x11-16″; exhaust port 7″x1⅜″; outside lap of valve ⅝″; inside lap 1-16″; travel 2½″. Such an engine, under the conditions named, should develop 20 to 25-horse power.

(90) A. M., Lawrence, Kan., asks: Would a steam gauge placed on a 2″ pipe, fifteen feet from the boiler, give correct boiler pressure, or what would be the difference in the indications between it and one on the boiler, both taking steam from the dome? *A.*—If steam is not being drawn from the 2″ pipe, there would be, practically, no difference in their indications. If steam were being taken from the pipe, the gauge on the boiler would indicate the most pressure.

(91) W. J. F., Macedon, N. Y., asks: How would a steam yacht be for speed, the hulls being catamaran, the two hulls being 6 feet apart at bow and 7 feet at stern, 42 feet length over all and 12 feet wide, the hulls to be pointed at both ends and straight on inside. The engine to be 4½″x6″, to make 300 revolutions per minute, propeller two-bladed 30″ diameter? *A.*—We should say that your engine power would not be one-half as much as it should be, and that with such an arrangement the speed might reach five miles an hour. Before building a catamaran steam yacht, we should advise that you find and examine a successful one. The failures of small catamaran steamboats have been numerous.

(92) E. F., Philadelphia, Pa., asks: 1. If in the cylinder of a non-condensing engine the pressure is 50 lbs. per square inch, what will it be with a condenser, and why? *A.*—It will be 50 lbs., as before. The condenser does not add anything to the pressure; it simply removes more or less perfectly the back pressure due to the atmosphere. This back pressure is ordinarily about 14.7 lbs. per square inch, from 6 lbs. and upwards of which may be removed by the use of the condenser. 2. Why is so much water required to condense the steam? *A.*—Aside from leaks, the vacuum in the condenser is due to the temperature, hence cold water enough must be used to keep the temperature sufficiently low.

(93) Inquisitive, Pittsburgh, Pa., writes: I am making patterns for a double engine 4″x5″ cylinders. I intend making the steam ports 5-16″ by 2⅞″, exhaust port ⅝″x2⅞, and bridges 5-16″. The steam pipe from boiler is to be 1¼″ to T, and branches to engine ¾″. The exhaust pipes will be 1½″. Are the ports large enough for full power at 250 revolutions, what lap should the valve have, and what will be the power with 60 lbs. steam? *A.*—Longer ports, say 3½″ long, would be better. If you keep the ports 2⅞″ long, make steam ports ⅜″ wide, exhaust port ⅞″, bridges ⅜″, outside lap of valve ⅜″, inside lap 1-16″, travel of valve 1½″. Main steam pipe should be 1½″, branch pipes 1″. Indicated horse-power, about 6.

(94) A Reader, Brooklyn, N. Y., asks: 1. A boiler is to be tested with cold water to a pressure of 100 lbs. per square inch. My friend says if I set the safety valve to blow off at 100 lbs, it will lift when the pressure by gauge is 80 lbs. I say that it will not lift till the pressure is 100 lbs. Which is right? *A.*—You are. 2. Take two plates, each 12″ square, surfaced together exact, and inclose them in air-tight box, and how much force will it take to move one plate on the other? *A.*—We do not think exhausting the air will make any material difference. 3. If steam of 20 lbs. pressure is admitted to the box, what will be the difference in the power required to move the plates one on the other? *A.*—We think the admission of steam would not materially change the results. 4. If I cut a hole 6″ square through the bottom plate, will it require more force to move one plate on the other? *A.*—If the under side of the hole is exposed to the atmosphere, you will have a pressure on the upper plate of at least 36x20=720 lbs., consequently it will take more power to move one plate upon the other, how much more depending upon the nature of the surfaces and the lubrication.

(95) E. H. C., Rockford, Ill., asks: 1. Will hot water injure a Portland cement cistern? *A.*—If quite hot, it will be almost sure to cause the cement to crack or check. 2. What causes a steam gauge to tremble from 5 to 15 lbs. through the week, except Monday? The pipe is attached to the top of water column. *A.*—Why there is an exception in favor of Monday is not clear, unless the work on the engine is less Monday than other days. The cause of the trembling is probably a reduction of pressure every time the engine takes steam, and could undoubtedly be reduced in extent by connecting the gauge to some other and quieter part of the boiler. 3. I feed my boiler through the front end by means of a pipe that runs nearly to the back end, then crosses over and down between the flues. After we had been running about three months, I found that the end of the feed-pipe was nearly closed with lime, and yet I have been pumping about a quart a day of purge into the boiler for the last sixteen years. How can I remedy this? *A.*—Where the water is limy, the feed-pipe, arranged as you describe, is likely to stop up in time, as the water, in passing through the pipe, will become heated sufficiently to separate the lime. We know of no remedy for this, except you get the lime out of the water before it enters the boiler. 4. My whistle is about forty feet from boiler, some of the pipe connecting it being 1¼″. I cannot get much noise from the whistle, but think if the pipe was all 2″, with a drip at the lower part, it would do better. Am I right? *A.*—Not knowing the size of whistle and steam pressure, we cannot say, but your view of the case looks reasonable.

BUSINESS SPECIALS

Transient Advertisements, 50 cts. a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Wednesday for the ensuing week's issue.

Gears—G. B. Grant, 3 Alden st., Boston; water motors

Presses & Dies, Ferracute Mach. Co., Bridgeton, N. J.

James W. See, Consulting Engineer, Hamilton, O.

Steel Name Stamps, &c. J. B. Roney, Lynn, Mass.

F. VanWinkle, Mech. Engin'r, 22 Cortlandt St., N. Y.

"How to Keep Boilers Clean." A book mailed free, by James E. Hotchkiss, 86 John street, N. Y.

Fine tools and special machinery. Horace Thurston, 84 Clifford street, Providence, R. I.

Spanish translations of catalogues, circulars, &c. J. M. Da Rosa, 260 East 3d St., Cincinnati, O.

Lyman's Gear Chart. How to lay out gear teeth. Price 50 cents. E. Lyman, C. E., New Haven, Conn.

Wood Engraving done in best manner. Designs furnished. Edward Sears, 48 Beekman St. New York.

Foot Power Machinery, for workshop use, sent on trial if desired. W. F. & John Barnes, Rockford, Ill.

The latest Improved Tack and Match Machinery is made by White Machine Co., Waterbury, Conn.

Patents.—Franck D. Johns, Att'y at Law & Solicitor of Patents, 617 Seventh St., Washington, D. C.

Pattern and Brand Letters. Vanderburgh, Wells, & Co., corner Fulton and Dutch streets, New York.

Universal grinders for lathe-centers, chucks, angles, or cylinders. C. C. Hill, 144 LaSalle st., Chicago, Ill

R. Dudgeon, 24 Columbia st., New York, Improved Hydraulic Jacks and Roller Tube Expanders.

Herbert W. T. Jenner, Mechanical Engineer and Solicitor of Patents, 626 E st., Washington, D. C.

Machine tools and supplies, steam engines, gas engines, ⅛ to 1 H.P. Send for large illustrated catalogue. Jackson & Tyler, Baltimore, Md.

Guild & Garrison's Steam Pump Works, Brooklyn, N. Y. Steam Pumping Machinery of every description. Send for catalogue.

The "Wax Process" Engravings shown in the AMERICAN MACHINIST each week are made by Struthers, Servoss & Co., 32 Frankfort Street, N. Y.

New Books, relating to steam, the steam engine, mechanics, machinery, and engineering. Send for catalogue. Fred. Keppy, publisher, Bridgeport, Conn.

Engine Lathes, Hand Lathes, and other fine tools. Assortment large; prices low. Frasse & Co., 62 Chatham St., N. Y.

H. O. Reinhardt, M. E., Mem. Am. Soc. Mining Eng., Chihuahua, Mex., invites correspondence of man'f'rs of machinery desiring to introduce same in Mexico.

The Complete Practical Machinist, $2 50; the Pattern Maker's Assistant, $2.50; Mechanical Drawing Self-taught, $4 00; books for practical machinists. Address, Joshua Rose, Box 3,306, New York City.

"Recent Locomotives."

Specifications and large-scale engravings, with details, of 70 present types of locomotives. $5. For sale by the Railroad Gazette, 73 Broadway, New York.

BOUND VOLUMES of the AMERICAN MACHINIST for 1880, 1881, 1882, and 1883, for sale at $3 50 per volume, express charges to be paid by purchaser. We will pay 50 cents per copy, to any of our readers who will forward us the first two numbers of 1881, or Nos. 1 and 3 of 1882. They must be clean and in good order. AMERICAN MACHINIST Pub. Co., 96 Fulton Street, New York.

Any of our readers who have complete files of Volumes I. and II. in good condition, bound or unbound, can probably find a purchaser by addressing us, and stating the lowest price they will accept. AMERICAN MACHINIST PUBLISHING COMPANY, 96 Fulton street, New York.

EXTRACTS FROM CHORDAL'S LETTERS, containing nearly 400 pages, 12mo., handsomely bound in cloth. New and enlarged edition, with additional illustrations, many of them humorous and all effective; over 50 in all. Just the thing for a holiday or birthday gift. Price $2. Published by John Wiley & Sons, 15 Astor place, New York.

Useful Information for Steam Users—A 100-page pamphlet, compiled from the best authorities, on the care and management of the steam engine and boiler, with hints and rules for engineers and firemen. Engineers everywhere should have this work. Send 25 cents in P. O. stamps for a copy. The J. N. Mills Publishing Co., 245 Broadway, N.Y.

Patent "Common Sense" Binder for the AMERICAN MACHINIST holds 52 weekly issues in good shape. Sent to any address, in the United States, by mail for one dollar. To Canada and foreign countries 75c., the purchaser to pay custom-house duties and express charges. American Machinist Publishing Co., 96 Fulton street, New York.

MANUFACTURES.

Parties at Oxford, Mass., propose to start a machine shop.

Owensboro, Ky., will probably have a $200,000 cotton factory.

A large brick tobacco factory, 100x300, will probably be built in Mt. Airy, N. C.

J. I. & W. C. Waite, of Eastman, Ga., will establish a machine shop in that town.

Rockingham, N. C., is having a new cotton mill, 320x60 feet, and two stories high.

New York capitalists are to build a foundry and machine shops at Sioux Falls, Dakota.

J. K. Brunners, of Rome, Ga., will be treasurer of the new cotton mill to be built at Dalton.

Colonel C. M. Jones, of Cartersville, Ga., has organized the Empire Woolen and Flour Mills.

Max Guggenheimer, and others in Lynchburg, Va., are trying to raise money for a cotton factory.

The Deane Steam Pump Company, Holyoke, Mass., has recently declared an 8 per cent. dividend

Colonel D. F. Houston, of Roanoke, Va., is organizing a nail factory, the plant of which is to cost $60,000.

Kinney & Watson, Houlton, Me., will put in two steam engines next spring for manufacturing purposes.

William Goulding, of New Orleans, will establish and equip a new shop to make a new engine of his own designing.

The Elmira (N. Y.) Rolling Mill Company, are making some extensive changes, in engines, boilers, and new machinery.

The Griffin Cotton Manufacturing Company, of Griffin, Ga., will increase stock to purchase machinery, &c. Capital, $84,000.

G. W. Wheeland, Chattanooga, Tenn., is making such improvements at his foundry and machine shop as to double his capacity.

The R. H. Jones Manufacturing Company has been organized in Cartersville, Ga., with $35,000 capital, to manufacture wagons and carriages.

John Clinton has purchased the property of the Brownsville (Tenn.) Manufacturing Company, and will endeavor to organize a company to rebuild the cotton factory.

The Michigan and Ohio Railroad Company has decided to locate its shops at Marshall, Mich. Work will be commenced on them at once, and pushed as rapidly as possible.

Sterling Elliott, Newton, Mass., has begun to manufacture a pamphlet stitching machine of his own invention. It stitches thirty to sixty pamphlets a minute, operated by one girl.

Samuel N. Shreve has purchased the entire works and effects of the Robbins Manufacturing Company, Camden, N. J., and will continue the building of Gray's patent revolving head-screw machine.

A Cincinnati firm has leased the rolling mill of Noble Brothers, at Rome, Ga., and will establish an extensive wood-working machine shop, build railroad cars, &c.—*Baltimore Manufacturers' Record.*

John McLaren, Hoboken, N. J., has purchased a site to build a new machine shop and iron foundry. He will do the repairing for the North German Lloyds Steamship Company as well as other work.

J. L. Spencer & Co., Oneida, N. Y., have nearly completed a new carriage factory. The main building is 125x60 feet, four-stories high; engine and boiler room 25x60 feet; new boiler, 5x14 feet, and new engine, 14x21″ cylinder.

The Singer Sewing Machine Manufacturing Company's works, at Elizabethport, N.J., are turning out 11,000 sewing machines every week. They employ about 3,000 hands at present.

The Beckett & McDowell Manufacturing Company, 120 Liberty street, New York, have issued a new illustrated catalogue and price-list of their steam engines and mining machinery. Quite a variety of styles are shown.

The cotton-seed oil mill to be erected by the Fort Worth (Tex.) Oil Manufacturing Company will use forty tons of seed per day, and the ginnery will have a capacity of fifty bales a day. The whole capital of $50,000 has been paid in.

J. D. Lynde, Philadelphia, is doing a good business, making safety valves, injectors, and steam fittings. His shop, in Fetter Lane, keeps a full force of men going, and the hard times do not seem to exert any depressing influence round there.

The *Manufacturers' Gazette* says the Mason Machine Works, Taunton, are giving work to a large portion of the employes week and week by turn. The men express themselves better pleased with this arrangement, than by the employment of all, for full time, at reduced wages.

Dean Brothers Steam Pump Works, Indianapolis, Ind., have issued a new illustrated catalogue of their well-known steam pumps. Pumps for a wide variety of purposes are shown by cuts; also, views of each of the sixty-one parts of a Dean pump, for convenience in ordering parts for repairs.

The Feigel Car Company, 108 Wall street, New York (works at New Utrecht, L. I.), are building a number of street cars for the Crescent City Road, at New Orleans, also for the Atlantic Avenue line of Brooklyn. They have lately made seventy-five sugar-plantation cars, of a peculiar design, for Cuba.

The Abendroth & Root Manufacturing Company, 28 Cliff street, New York, have issued a new descriptive catalogue of the new Root wrought-iron sectional safety boiler, recently illustrated in the AMERICAN MACHINIST. It is finely printed, and tells about everything a boiler purchaser wants to know, except prices.

The Troy (N. Y.) Mowing Machine Company (limited), has been incorporated with $25,000 capital. The incorporators are William Gurley, Lewis E. Gurley, William Kemp, H. Galusha, and N. Davenport. These names give evidence that the company means business. They propose to manufacture mowers, reapers, and other agricultural implements.

The Portland Company's shops (Portland, Me.) are full of business. They are building three locomotives for the Maine Central, three for the Eastern, and one for the Worcester and Nashua railroads; a boiler for the pleasure steamer City of Portsmouth, a large wind pipe for the Portland Rolling mills; and there are one hundred freight cars to be repaired for the European and North American division of the Maine Central Railroad.

Hilles & Jones, Wilmington, Del., have issued a new illustrated catalogue of iron-workers' tools, manufactured by them; such as punches, shears, radial drills, bending rolls, plate planers, engine lathes, and the like. Over a hundred pages are occupied by cuts and plain descriptions. They make a line of tools for boiler makers, and in the preface to catalogue invite visitors to see what good tools will do in regular practice in their own boiler shops.

The New England Ship Building Company has been formed, at Bath, Me. It comprises the firms of Goss, Sawyer & Packard and Goss & Sawyer, and a number of individual capitalists, with capital of $500,000. The two firms contribute $400,000, and Captain Goss will manage the business. The company will own the ship-yards, mills, &c., of the above firms, together with a marine railway and other properties. They have contracts amounting to $300,000. Sylvester Marsh, of Concord, N. H., is president; Guy C. Goss, vice-president; and B. F. Packard, G. W. Hyde, Arthur Sewall, of Bath; and B. F. Caldwell, of Concord, directors.

J. S. Graham & Co., Rochester, N. Y., report business in wood-working machinery very good. They have recently booked orders for a large number of machines, and are filling several large orders for complete outfits for mills, among which we notice one from the Ames Manufacturing Company, Syracuse, N. Y., for forty machines; one from G. A. & A. S. Mundorff, of Pittsburgh, Pa., for thirty-six machines; Williams, Miller & Co., of Bradford, Pa., two machines; Johnston Harvester Co., Batavia, N. Y., two machines; besides orders from the Stuart Manufacturing Company, of Newark, N. Y.; Orr, Fowler & Co, Brooklyn, N. Y.; and others from Baltimore, St. Louis, and Williamsport.

Lowe & Watson, Bridgeport (Conn.) Boiler Works, exhibited a pair of Lowe tubular boilers of 100-horse power each, at the Louisville Exposition, which furnished steam to run about 6,000 Edison lights. The managers awarded them the big bronze medal. The builders claim that, owing to the peculiar construction of these boilers, the soft, smoky coal and river water can be used in them more satisfactorily than in the ordinary tubular boiler, especially with Lowe's Feed-water Heater. At the fair, these boilers worked as well with such fuel and water as the flue boilers beside them, and with more economy. The Lowe feed-water heater also obtained an award at the Exposition. Lowe & Watson have had many applications for boilers and heaters from that region of country, and expect to get more orders from there.

Machinists' Supplies and Iron.

NEW YORK, February 14, 1884.

The conservative tendency of buyers to supply only their immediate wants continues, and the regular business has been considerably interfered with by the floods in the leading iron districts.

In Iron there is a slight improvement over prices quoted last week. No. 1 X Foundry is quoted at $20.50 to $21; No. 2 X. Foundry, $19.50 to $20; Grey Forge at furnace, $16.50 to $17.50.

Scotch pig is dull, with few sales. Coltness is quoted at $22, to arrive, and $22.50 to $23 from yard; Glengarnock, $22.50; Gartsherrie, $23; Summerlee, $22.50; Eglinton, $20 to $20.50; Langloan, $22; Dolmellington, $20.75.

Copper is quiet; Lake, 14¾c. to 15c.; Baltimore, 14c. to 14¼c.; other brands 14⅜c. to 14½c.

Lead—There have been considerable sales of pig at 4.10c., but holders now ask 4.25c. Buyers do not want to rise, and the market is quiet.

Spelter—The market for Western brands has ruled quiet and steady, at prices ranging from 4.30c., for ordinary brands, up to 4.80c. for choice.

✲WANTED✲

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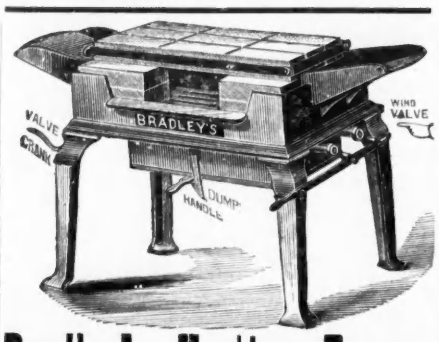

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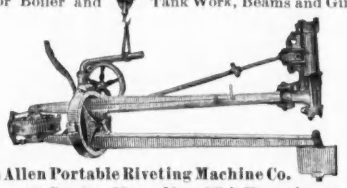

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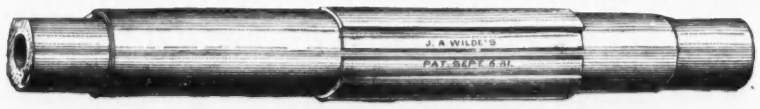

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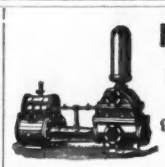

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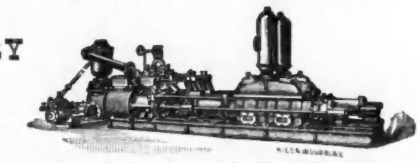

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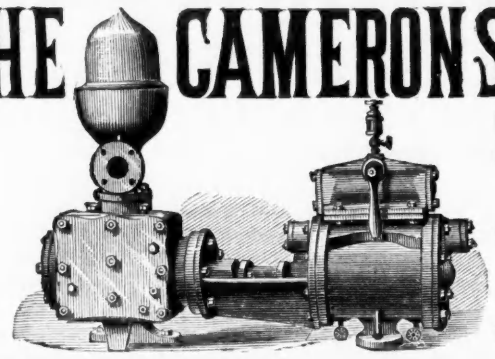

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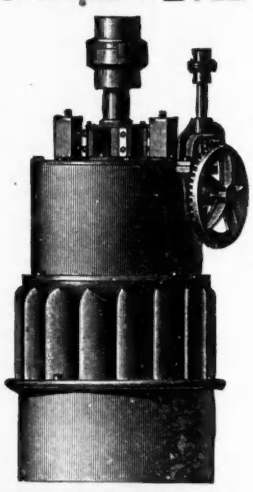

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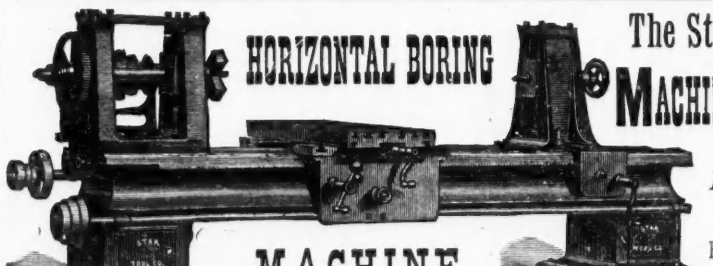

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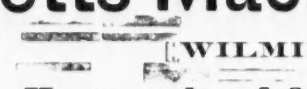

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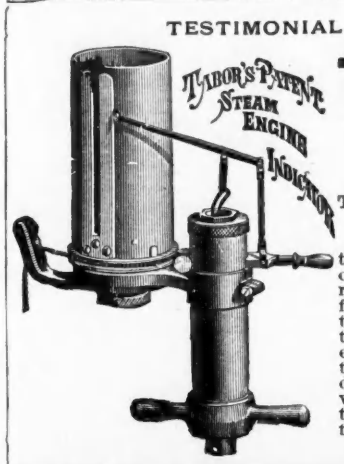

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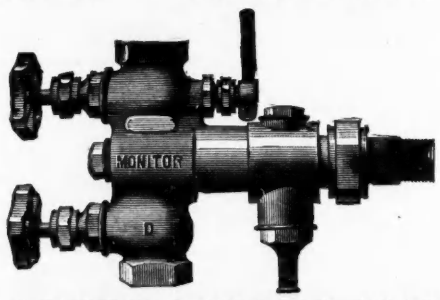

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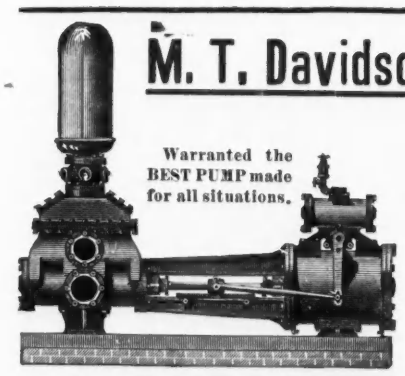

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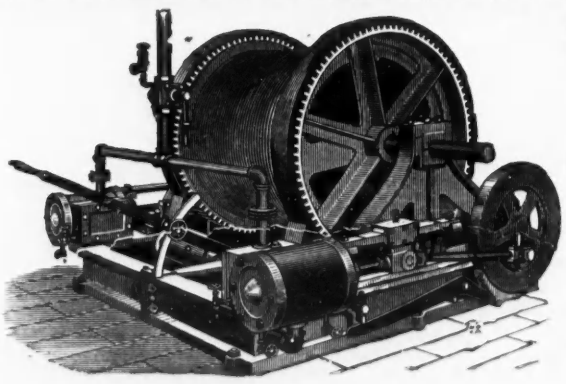

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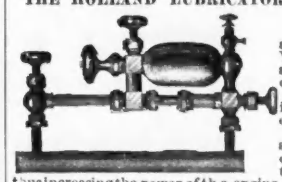

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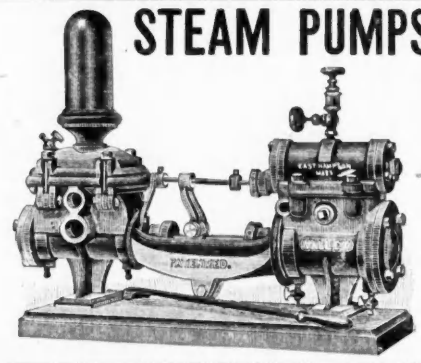

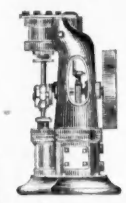

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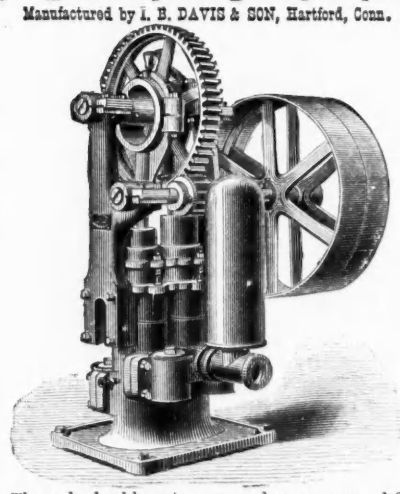

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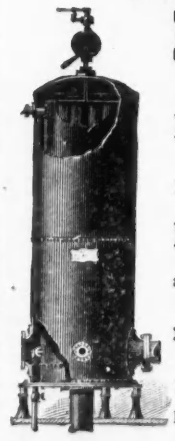

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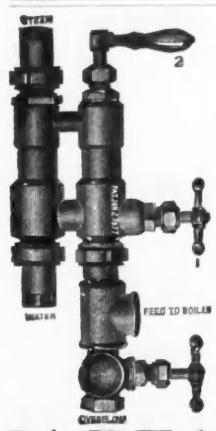

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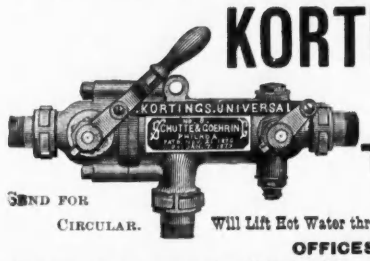

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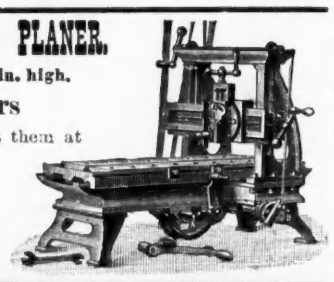

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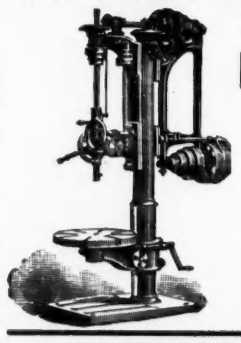

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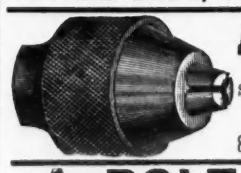

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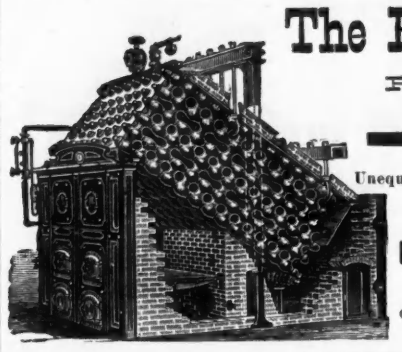

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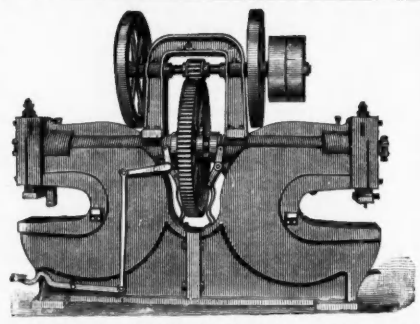

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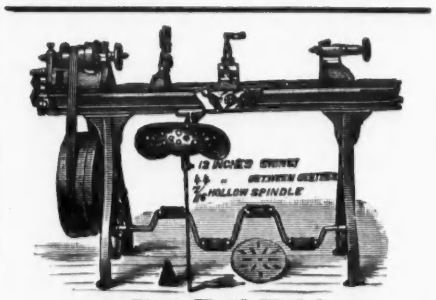

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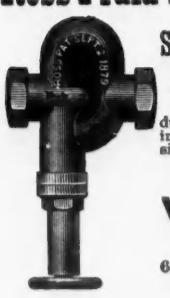

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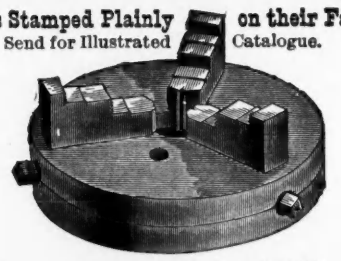

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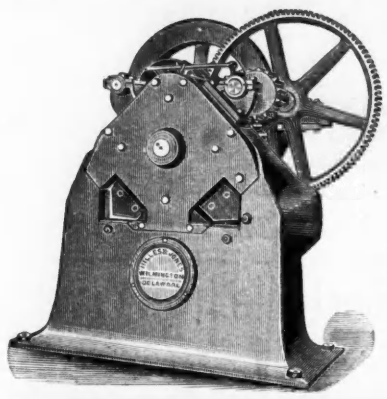

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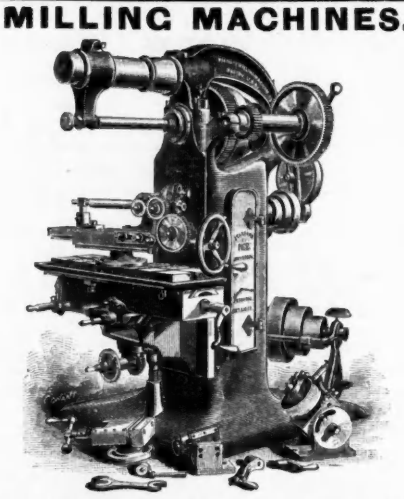

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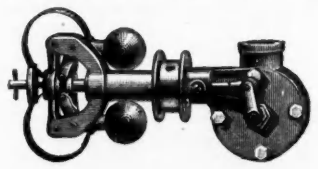

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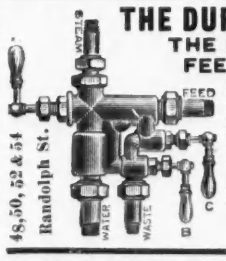

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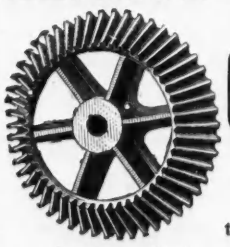

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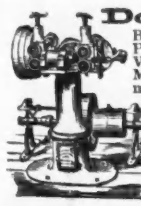

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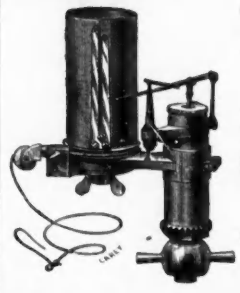

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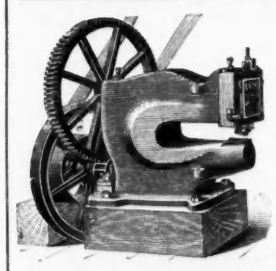

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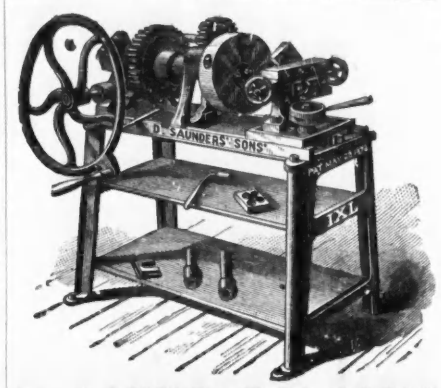

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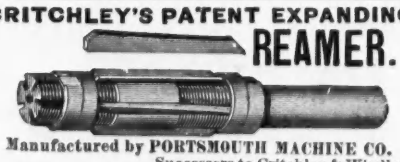

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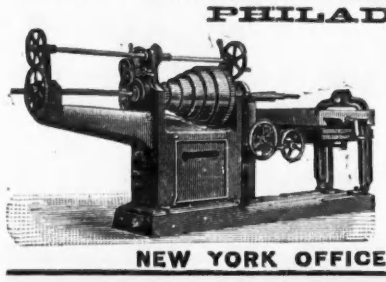

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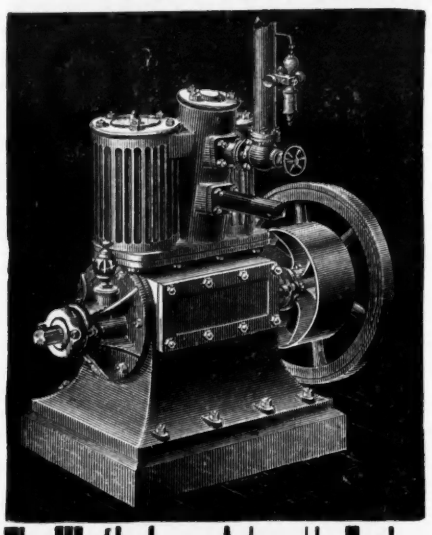

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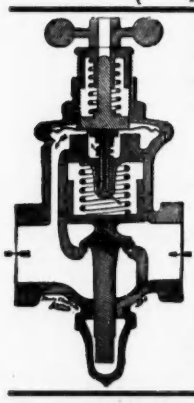

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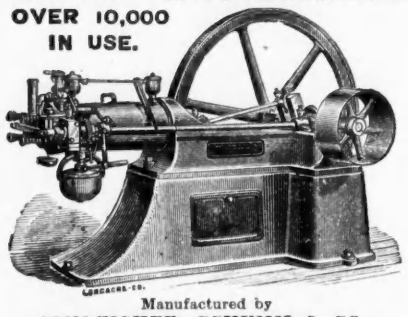

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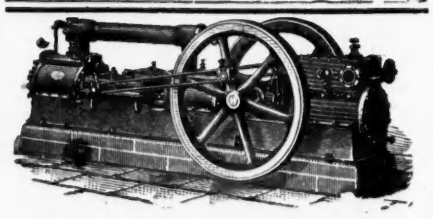

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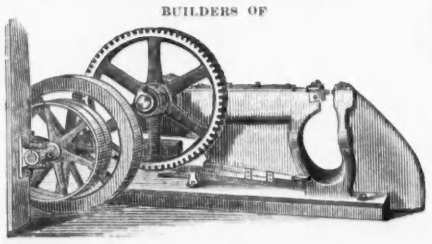

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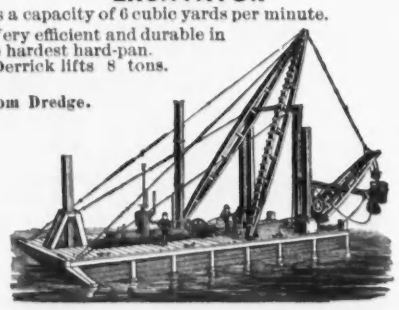

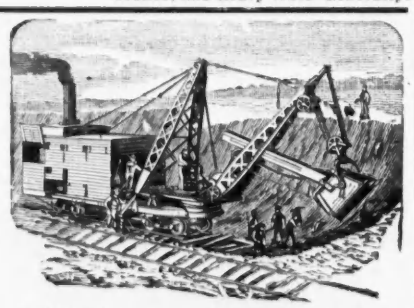

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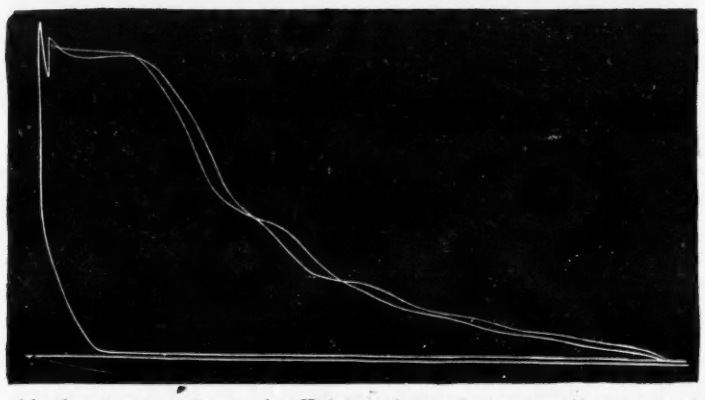

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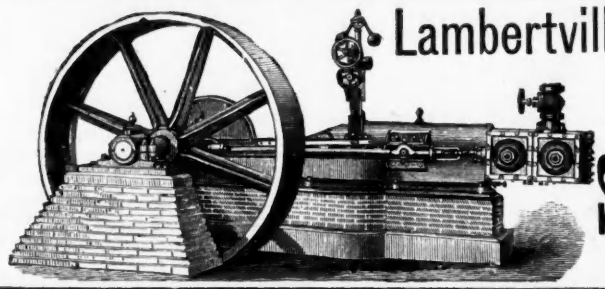

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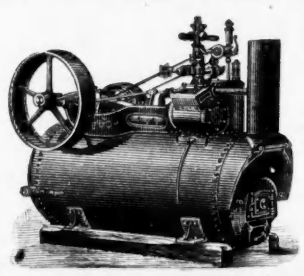

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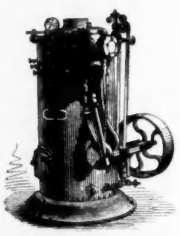

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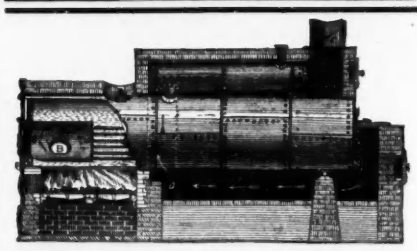

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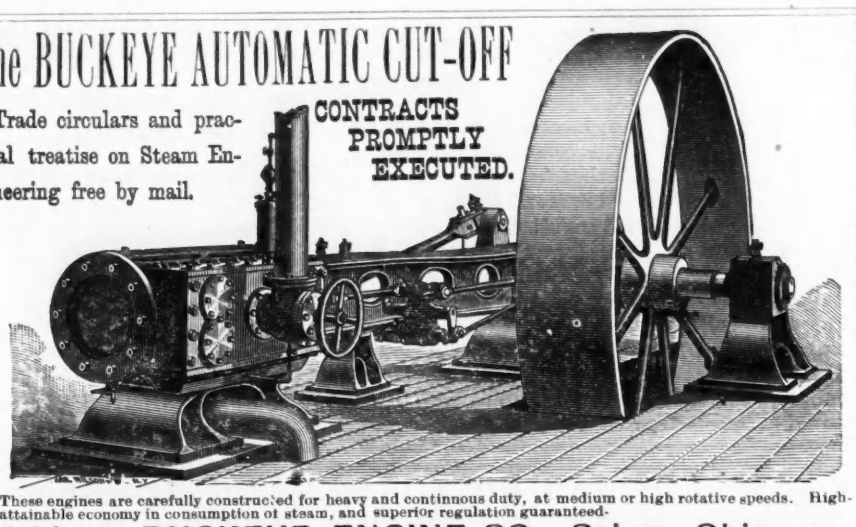

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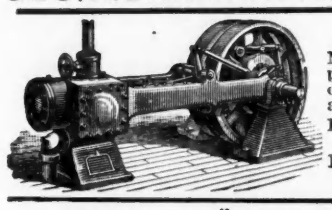

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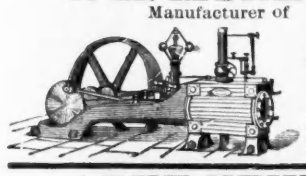

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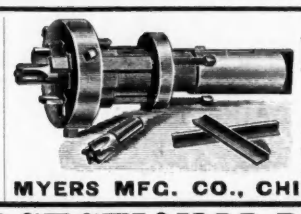

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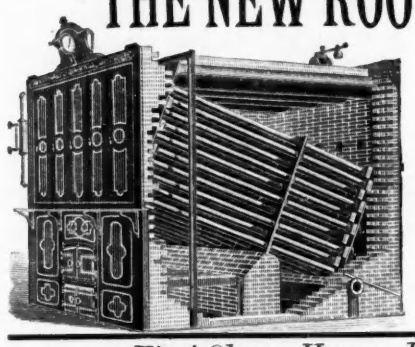

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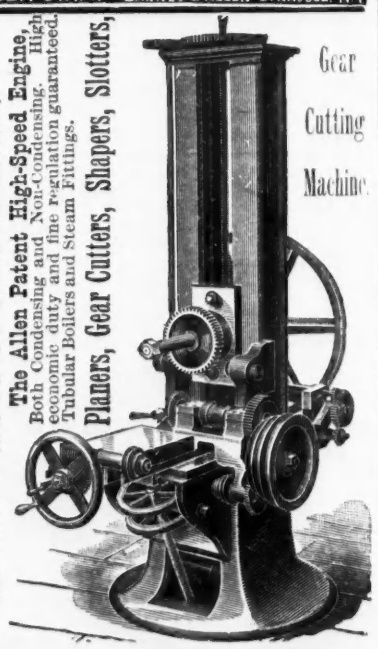

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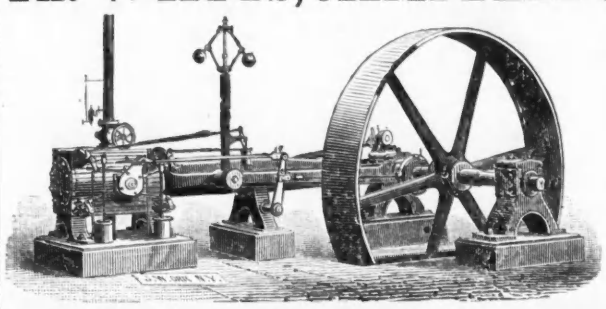

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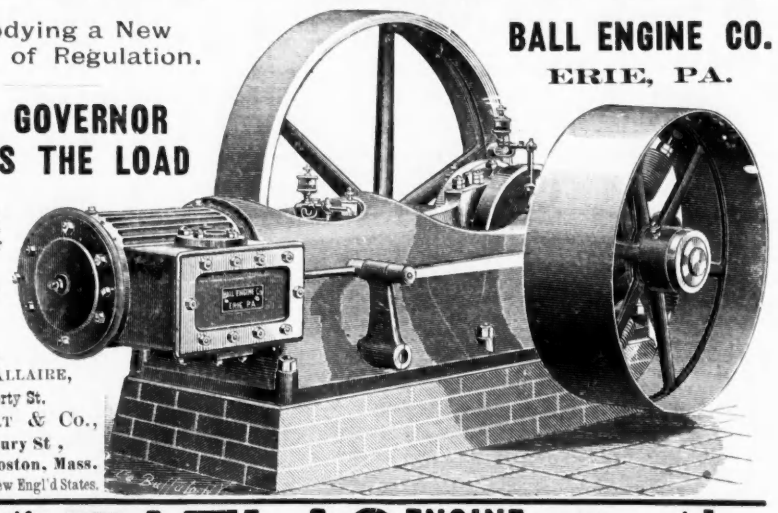

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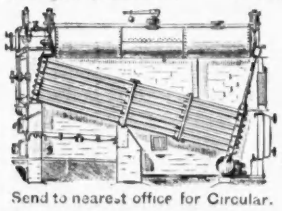

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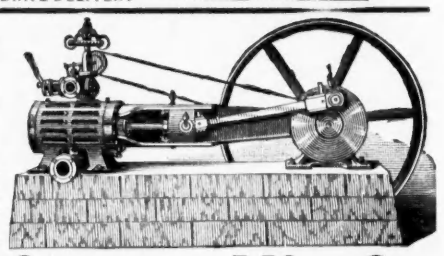

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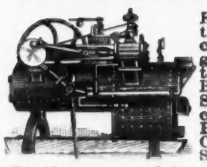

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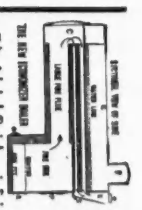

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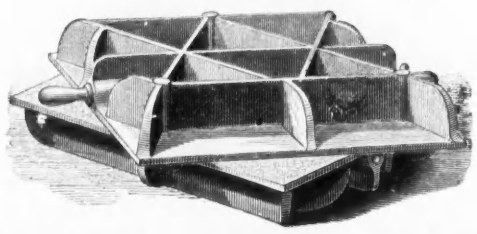

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10″x 15″	25	10″x 30″	45
14″x 14″	30	24″x 24″	88

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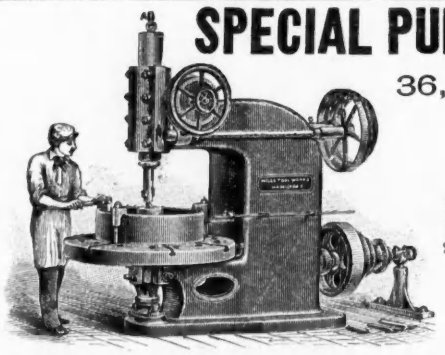

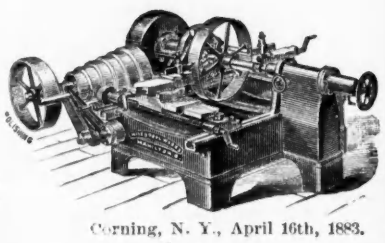

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B. W. PAYNE & SONS.

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CAPACITIES FROM ½ TON TO 10 TONS.

ONE MAN CAN LIFT 5,000 POUNDS.

THEY HOLD THE LOAD SUSPENDED AT ANY POINT.
ALL SIZES IN STOCK.

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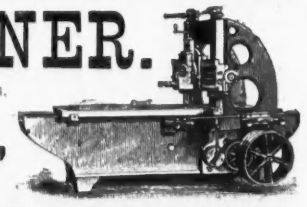

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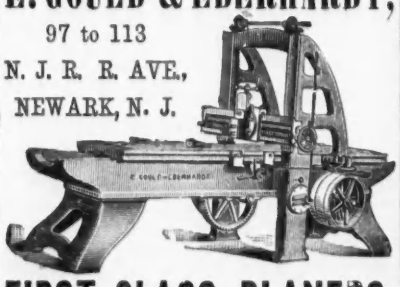

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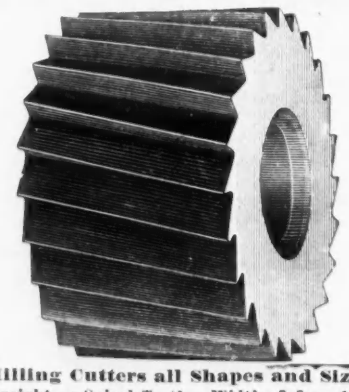

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Straight or Spiral Teeth. Width of face, 1-8 in. to 3 in. Diameter, from 2 1-4 in. to 2 3-4 in.

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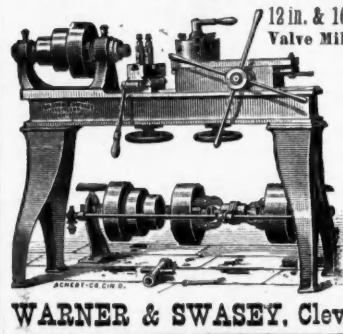

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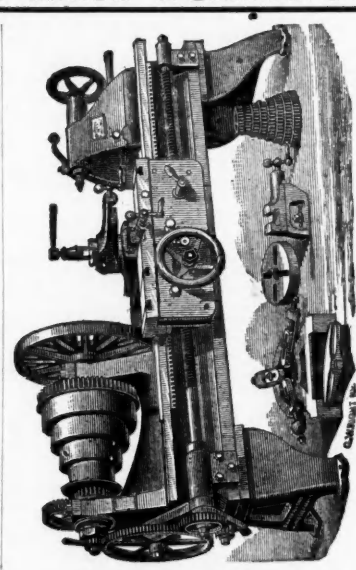

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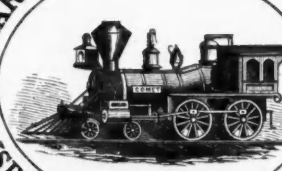

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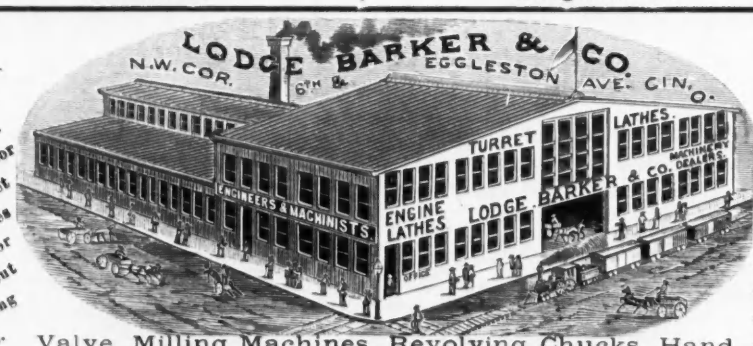
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